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TECHNOLOGY
AND THE FUTURE OF
MONTANA'S ECONOMY

Report to the Governor's Employment
and Training Council
Department of Labor and Industry

April 1979

ABSTRACT

The principle theme of this paper is technology and its influence on economic stability within Montana. Chapter 1 reviews the importance of technological change at the national and state level. A brief economic history of Montana is also discussed in light of how technology has helped to shape the state. Chapter 2 focuses on primary industry and the effects of productivity change on employment and output. Potential technological events in the future and their impacts are considered. Chapter 3 summarizes technological potentials and constraints to growth for each major industry within Montana. Employment and population projections are developed based on likely changes in technology and demand.

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CHAPTER I

TECHNOLOGY AND ECONOMIC CHANGE

Introduction

Technology, "man's efforts to satisfy his material wants by working on physical objects," goes back to his very beginnings. All that has transpired since the development of material culture - in how man does things - is technology. Clearly, these technical advances are often responsible for extensive social changes. Indeed, the significance of a new discovery is frequently judged by its social rather than scientific effect. The printing press, internal combustion engine, and synthetic materials, for example, have had profound social impacts. The longbow, gunpowder and more recently nuclear weaponry have also had an effect, but of a vastly different nature. The influence of technology has been so overwhelming as to completely remold the self-image of the human race and to totally alter its relation to its environment.

Our world today is full of examples which attest to the influence of technology. How one regards the benefits and costs of such change is largely a matter of personal perception. But, the fact remains, it has been a "revolution," good or not.

On the positive side, technological change has improved working conditions by eliminating many, perhaps most, dirty and menial jobs, permitted the reduction of working hours, dramatically increased the level and type of trade, and added many new dimensions to our lives.

This affluence, however, has not been without cost. Self-sustaining growth necessitates technological development and technology begets growth in a never ending cycle. Some would argue, with

this or that new tool, the world could be molded into almost any desired shape - except back into its original one. The cost of technological intervention has been high, and each succeeding "technological fix" may only create a newer and possibly more extensive disruption.

The present crises in energy, general resource depletion, environmental pollution, arms control, and third world inequities are each in their way consequences of unrestrained technology, growth, and careless use of science. These sorts of issues may suggest physical limits to growth regardless of the technology or how it is used.

The balancing of jobs and income and other favorable aspects of technology against air and water pollution, the closing of plants made obsolete by technological change throwing whole communities into distress, etc., represents one of the most pressing issues of our time. Ironically, technology properly used may resolve many of our economic problems, or improperly used (or disregarded as important) may sink the ship. Although most people would agree, on balance, that technology has been beneficial, no one would claim that a price was not paid for the gain.

The purpose of this paper is to focus on technology and its influence on employment and economic stability over time. The effects of productivity increases on the nation and on Montana are reviewed in the following sections. However, most of the discussion in the later sections of the paper is geared toward an assessment of "predicted or possible" events which may affect specific Montana industries in the future. In some cases, technological change takes a backseat to other more relevant influences. A series of industrial scenarios are developed which attempt to answer the basic questions . . .

1) What will be the relative economic stability of each sector?

2) Can Montana continue to grow as it changes from an agricultural and extractive base into a service and manufacturing economy? (Or, conversely, is this possible?)

3) How will long run changes in demand, technology, state and federal policy, etc., affect employment and population growth?

The nature of such speculation is, of course, imprecise since "breakthroughs" can not be predicted by definition. The intent is only to explore plausible influences, focusing on technology, which may affect the future of Montana's economy.

Technology Defined

What is technology? It could be broadly defined as - how man does something - or how man extends his power over his surroundings. Our knowledge of the ways of doing something constitute the constraints of technology. However, the actual limits of technology are further narrowed by economic feasibility. That is, just because a certain process is known and technically feasible does not guarantee that that same process will be implemented. It may be either too expensive or socially unacceptable.

Technology is not merely concerned with tangible objects - a saw, a spade, a dragline, etc., - but with everything else which extends the ability of man. This includes labor skills and general knowledge, which cannot be measured by normal yardsticks.

Technology is sometimes categorized in terms of divisions of historic time - Stone Age, Bronze Age, Iron Age . . . . . Nuclear Age - names given to man's implements in those eras. The passage from a primitive to a civilized condition marks the point at which man's

will became predominant as opposed to natural forces. The goal of technology has been to control natural forces (e.g. matter and energy), whereas, the goal of science has been to comprehend them. Within the relatively recent past, these separate efforts have conjoined to forge a tool of nearly irresistible force - a technology based on science and born by the nineteenth century industrialization.

Technological change has generally mystified both layman and economist. What is it? Is it the product of a hero inventor, a scientific discovery, the force of learning more? Is it motivated by academic tinkering, profit or power?

Unless there is a revolution in statistical techniques (unlikely), only one type of productivity concept is quantifiable . . . output per unit of input. Common measurements of this class include output per man hour, output per gallon of fuel, etc., or output per dollar of investment. These represent the only feasible types of measurement but, certain problems exist. For example, if productivity is measured in terms of man hours, is it measured with respect to changes in skill or relative labor cost, both of which may vary? Similarly, the value of physical inputs (fuel, etc.) may change in a relative sense. And the same is true for return on investment for a variety of reasons.

These problems, however, are not related to problems of definition or measurement, but rather to interpretation. Greater precision in quantifying the contributions of technology to production is difficult to achieve.

Time and Technology

Though familiar to us now, detailed facts about most budding ideas

or developments-in-progress were quite unknown, during their incubation period, to the average man-in-the-street: the idea for frozen foods originated in 1908, but the foods themselves weren't introduced to the public until 1923; conceived in 1884, television wasn't seen by most consumers until 1947, a time lage of more than half a century. Here are some other examples:[1]

TABLE 1

Development Periods

Innovation	Conception	Realization	Incubation Interval
Antibiotics	1910	1940	30 years
Automatic transmission	1930	1946	16 years
Ball-point pen	1938	1945	7 years
Cellophane	1900	1912	12 years
Dry soup mixes	1943	1962	19 years
Filter cigarettes	1953	1955	2 years
Heart pacemaker	1928	1960	32 years
Hybrid corn	1908	1933	25 years
Instant camera	1945	1947	2 years
Instant coffee	1934	1956	22 years
Liquid shampoo	1950	1958	8 years
Long-playing records	1945	1948	3 years
Nuclear energy	1919	1965	46 years
Nylon	1927	1939	12 years
Photography	1782	1838	56 years
Radar	1904	1939	35 years
Roll-on deodorant	1948	1955	7 years
Self-winding wrist-watch	1923	1939	16 years
Video tape recorder	1950	1956	6 years
Xerox copying	1935	1950	15 years
Zipper	1883	1913	30 years

Many examples of current technology took a decade or more to bring to fruition. Just because the idea is there, or even the process, does not provide sufficient cause for implementation for reasons of profit or public acceptance. There is a host of potential developments which are now technically feasible but may never

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[1] Stephen Rosen, Future Facts, Simon and Schuster, New York, N.Y., 1976.

materialize. Examples of such changes are discussed in the industry specific sections.

The Sequence of Development

Although the following stages of growth are not universally true, most countries and regions sequentially follow certain phases of development. These stages are to a large degree the direct result of technological progress. The first stage is one of a self-sufficient subsistence economy heavily reliant on agriculture. With improvement in transportation, society begins to become more specialized, focusing on extractive industries. That is, the labor force available for nonagricultural pursuits has, in a relative sense, expanded since few individuals are necessary for agricultural production. With increasing population and diminishing returns in agriculture and other extractive industries, a region is forced to industrialize. Typically these early stages of industrialization are based on the products of agriculture and forestry and include such activities as food processing, milling of wood products or preparation of textile fiber.[2] As industrialization continues, the importance of energy resources becomes critical. A final stage is reached when a region or country specializes in exports. However, as productivity gains continue, requiring fewer workers in the goods producing sectors, the importance of service producing sectors (trade, services, and public employment) accelerates. This effect is the product of both rising incomes and fewer people required in traditional sectors. Montana and the United

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[2] E.M. Hover and Joseph Fisher, Research in Regional Economic Growth, National Bureau of Economic Growth, New York, N.Y., 1949, Chapter 5.

States are currently in this phase of development - occasionally called maturation. The drive toward higher and higher investment levels may begin to fall during this cycle possibly resulting in declining growth rates.

Technology may be used in a somewhat different manner at this level of development. That is, it may not be used to create major changes in the economy, but rather to maintain or perhaps slightly improve status of the region. (The energy crisis represents a good example of an attempt to maintain the status quo goal.) In addition, this period of development may also generate growing awareness that big may not be best with a change in emphasis from quantity to quality. Earth day, increasing levels of environmental control, and the current rush of interest in"soft path" technology are indicative of this line of reasoning. However, just as economic growth has resulted in environmental costs, increasing regulations are likely to result in constraints on economic growth. Again how an individual makes these "trade-offs" is again a matter of personal choice between "commodity" and "noncommodity" outputs or costs. Productivity, like beauty, exists in the eyes of the beholder. The costs and benefits of growth, progress, welfare, etc., escape quantification.

Technology - The National Perspective

The postwar period witnessed an upsurge of interest in productivity. With factors of production fully employed - both human and capital resources - technology and increasing the yield of available inputs took on center-place importance as the economic issue of the day.[3]

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[3] W.E.G. Salter, Productivity and Technical Change, Cambridge University Press, London, 1960, Chapter 1.

Concern about an expected business slump following the war - which never materialized - may have been partly responsible for this commitment to increasing output levels. This attitude was directly reflected by the Full Employment Act of 1946 designed to foster full utilization of resources and to maintain stable price levels. It became the declared aim of government to raise the productivity of industry.

Productivity gains during this era were further stimulated by an increasing awareness of the importance of human skills as opposed to "hardware" advances. This "revolution" began gathering momentum after World War II, "with the massive entrance into college of ex-GIs; with the concomitant explosion in higher learning and the growing acceptance of the social primacy of education; with the union of national power and modern science crowned by the harnessing of nuclear energy and the federal government emerging as a major sponsor of scienfific investigation; with the sudden birth of rapid continental communication, ranging from the world's most modern and developed highway system, through rapid air passenger transport, to a uniquely effective instant transcontinental telephone system, and finally to a nationwide television intimacy; with the transformation in managerial techniques wrought by the appearance of computers and other electronic devices that conquer complexity, distance, and even the diffusion of authority; and with the fading of industry as the most important source of employment for most Americans."[4]

Without question, technological change has been one, perhaps even the most important determinant of the shape and evolution of the

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[4] Zbigniew Brzezinski, Between Two Ages.

American economy. Denison's exhaustive study of the sources of economic growth in the United States (1929-1957) suggests that as much as 40 percent of the total increase in income (per person employed) was a result of productivity advances.[5] Later estimates by Denison and the Brookings Institution over a different time period attribute about a third of the increase in income to technology from 1927 to 1969. Estimates by Western Analysis covering the period (1960-1978) suggest that approximately 35 percent of the real income gain was associated with increasing output efficiency. This particular model also suggests that overall price changes (inflation) are also acutely sensitive to variations in productivity.

Research and development expenditures relative to GNP reached its peak in the mid 1960's. However, since that time relative levels have significantly declined as shown in the following table.

TABLE 2

Research and Development Expenditures
As a Percent of GNP

1960	2.7%
1965	2.9%
1970	2.8%
1971	2.5%
1972	2.4%
1973	2.3%
1974	2.3%
1975	2.3%
1976	2.3%
1977	2.3%

Source: National Science Foundation, National Patterns of R & D Resources.

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[5] E. Denison, The Sources of Economic Growth in the United States, Committee for Economic Development.

Does this recent change suggest that the U.S. is loosing its initiative in technological innovation and productivity? Perhaps, since yearly increases in output per man averaged 1.9% per year in the 1960's, but declined to 1.2% per year in the 1970's. The yearly growth in output per man hour has also fallen from 2.6% per year in the 1960's to less than 1.8% per year in the current decade.

There are several possible explanations for this relative decline. Charles Kindleberger, Ford Professor of Economics, points out that our industrial society may be maturing to a new state of development in which innovation is more subtle and perhaps crucial, further suggesting that productivity be measured by broader new standards. Jerome Wiesner, President of MIT, suggests that the United States is beginning to drift toward a great emphasis on "replacement technology" rather than new ideas. He accredits this shift to shortages of capital and investment incentives as a result of counterproductive patent policies, growing government regulations and changes in research support. (His premise appears to be born out by relative investment patterns over the last 15 years, i.e., fixed nonresidential investment as a percent of GNP or by new product investment.) He goes on to say that this series of deterrents to the creation and use of new knowledge is "a social overhead (cost) which the nation can not afford."[6]

A similar view is held by John W. Kendrick of George Washington University, who associates our decreasing productivity since the recession of the mid 1960's to seven trends:

- "less intensive use of plant due to reduced demand for U.S. products;

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6 J.B. Wiesner, MIT Conference on Productivity, 1976.

- the addition of many unskilled workers (inexperienced women and young people) to the work force;

- inflation which rendered depreciation allowances inadequate;

- increasing "non-productive" expenses to meet new environmental and safety laws;

- the prevalence of antibusiness and anti-establishment attitudes;

- distortions due to wage/price controls;

- reduced expenditures on research and development."[7]

The reduced emphasis on technology within the U.S. has not, however, been true at the international level. Elliot Richardson, former Secretary of Commerce, terms the situation a dilemma pointing out that - "If inequalities between developed and underdeveloped countries are to be reduced, then rates of innovation and productivity must be higher in third world nations than in - for example - the U.S. Without such a differential, the rich will grow richer and the poor even poorer.

But this phenomenon, fueled by our export of technology, has put us in the position of being hoist by our own petard, buying the products of our own innovation produced overseas at less cost than we can make them at home."[8]

One does not have to be an economist, however, to note the rise of foreign goods, many of them high technology products, in the U.S. market. Offsetting gains have been made by the U.S. exports, of course. But the leading edge of U.S. exports of technology-intensive goods to western Europe and Japan declined after a decade of growth.

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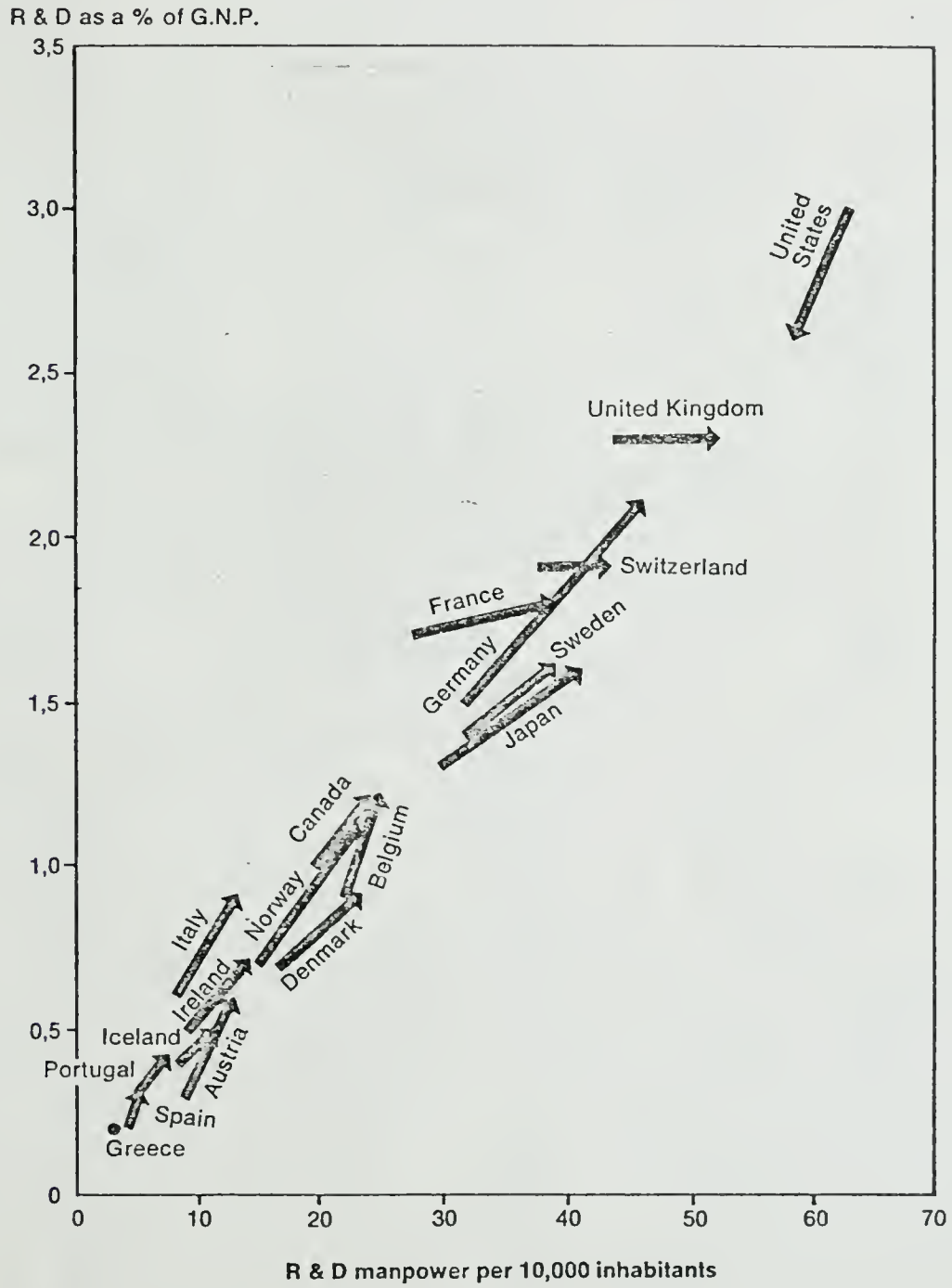
[7] J.W. Kendrick, MIT Conference on Productivity, 1976.

[8] E. Richardson, MIT Conference on Productivity, 1976.

Such changes are again clearly reflected by relative R & D inputs as shown in Diagram 1.

DIAGRAM 1

Emphasis on Innovation



The Effect on Jobs

Changes in techniques can result in the displacement of workers or at the very least can alter the composition of the work force. For the factory worker technology has overtones of 'automation,' and visions of redundancy. The businessman may delight in the addition of a new IBM easily replacing an entire office of clerks with 10 key adding machines. But as one job becomes obsolete another is created. Technology may eliminate certain categories of jobs - but certainly not work. Furthermore, periods of rapid employment growth and technological advance appear to be directly related in the aggregate and not conflicting events.

But, during the early 1960's, this personal view was not universally accepted. In 1962, President Kennedy stated that "The major domestic challenge of the 1960's is to maintain full employment at a time when automation is replacing men."[9] There was extensive debate concerning the extent to which unemployment rates (during that era) were the result of technology or due to an inadequacy of demand for goods and services. The later argument appears to have won out.[10]

However, no one would argue that the composition of employment has not changed and has not been to a large degree the result of changes in technology - favoring white-collar jobs and service-producing industries while dampening the growth of blue-collar jobs and overall employment in goods producing sectors, i.e., agriculture, mining, manufacturing. The following diagram depicts such a change

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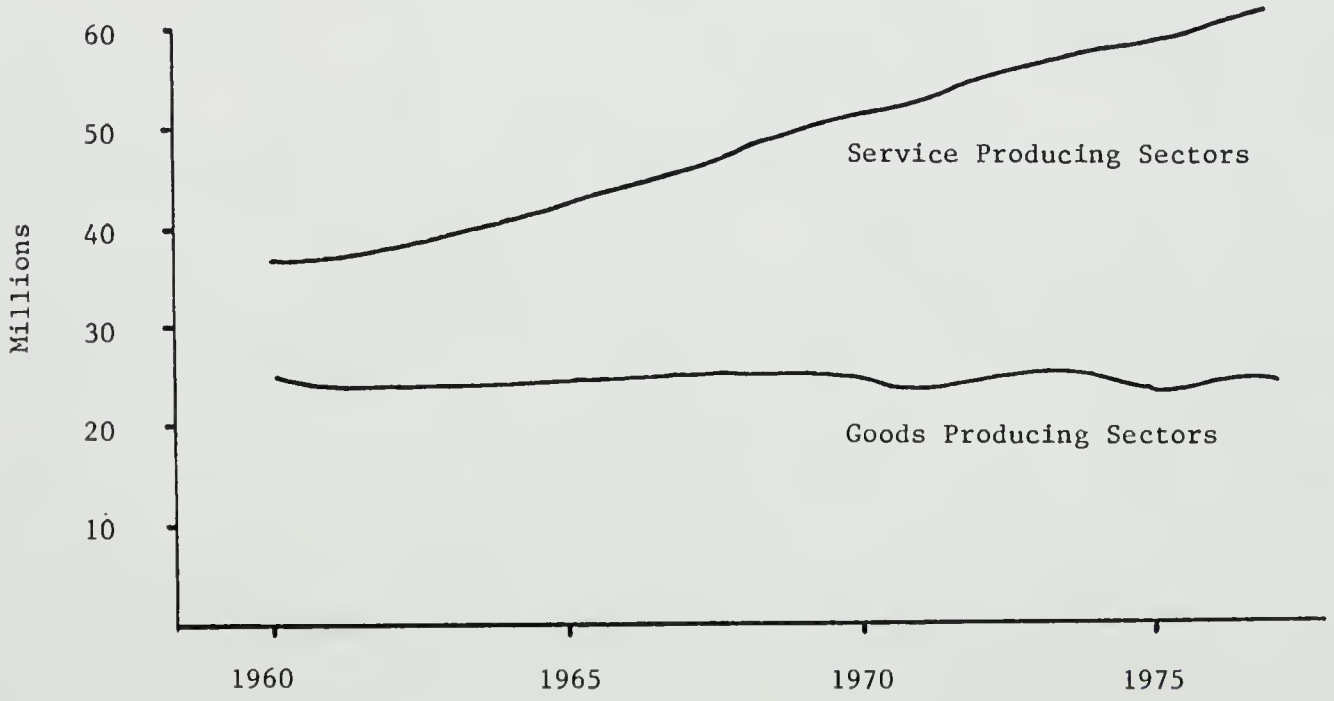
9 Quoted in J. Dunlop, Automation and Technological Change, The American Assembly, 1962.

10 R. Solow, The Nature and Sources of Unemployment in the United States, Stockholm, 1964.

DIAGRAM 2

National Employment



Source: Bureau of Labor Statistics.

in composition and growth.

Productivity gains have been much more rapid in the goods producing sectors than in the service category requiring relatively fewer production workers for an increasing amount of physical (or real dollars) output. But, measurement problems are extremely difficult if not unponderable for many industries within the service producing group. For example, how does one measure productivity where there is no commodity output - such as government - where over 25 percent of the employment growth has occurred since 1960. Significant, but less dramatic measurement problems exist in many other sectors within the service category even in private markets. Measurement in dollars to standardize sectors goes only so far since attitudes concerning the relative value of physical product and services apparently has changed.

Certain economists have argued that this accelerating build-up in service related activities is unproductive, inflationary, or growth based on a pillar of sand. Such debates are quite simply irresolvable. However, the fact remains that growth in these sectors has greatly contributed to overall income increases.

This changing emphasis on service related activities represents one of the dramatic long term changes in national and Montana economies. At the turn of the century nearly everyone was employed in some form of primary production, while today the situation is quite different, with more employment in the service and trade related sectors. This reversal appears to be the result of two principal factors. First, the rapid productivity increases in the primary industries displaced workers, many of whom found employment within the service and trade sectors. Secondly, overall income increased, both in Montana and nationally,

bidding up the demand for secondary activity. During this slow process, the state and nation became increasingly urbanized. There has also been a large increase in the labor force as a result of a change in the age structure of the population. The "baby boom" has resulted in more people entering the labor force than ever before. This age effect, coupled with the fact that more women are working, has greatly expanded the number of individuals seeking employment. The primary industries, where productivity has grown the most, have not been able to provide employment for these new workers. The service and trade sectors have not experienced this rapid growth in productivity and have absorbed these individuals. Simultaneously, consumption of the output of services and trade sectors has grown. Public and private sector services are increasingly substituted for activities once provided in the home. While it is true that many part-time positions have been offered in these sectors, even after adjustment for full time equivalents, the rate of increase in employment has been great.

In terms of measurable changes in the economy as a result of technological influence, input-output analysis provides another useful framework of analysis. Input-output (I/O) tables have been constructed for the national economy for the years 1947, 1958, 1967, and most recently for 1972. The tables reflect the linkages of one industry to another - up to 400 in the more recent versions. The technique takes into account the fact that the division of labor and other inputs within a modern industrial economy is embodied in a diversity of highly differentiated and mutually dependent technologies. For any given industry, the tables provide a detailed accounting of its purchases from other industries - specifying what inputs are used

to produce its products (outputs) - and thus describing its production process.

A comparison of the technologies over time shows a significant increase in "nonmaterial" or "general" inputs. The category of general inputs includes energy, trade, business services, printing, finance, construction and repair, etc. This increasing emphasis on service producing sectors may be partly explained by the growth of the relative importance of coordination functions required by a larger and more complex industrial system. Conversely, the classical dominance of traditional material inputs - metal, stone, rubber, plastic, etc. - has been declining. Purchases by final consumers (households) have followed a similar trend . . . relatively greater purchases of service related outputs rather than durables as a result of rising income or changes in tastes.

Changes in the I/O coefficients, of course, mirror the same change as shown by Diagram 2, in dollars rather than employment terms.*

The Montana Experience

> "Will those who see the close of the Twentieth Century look back and wonder how the people of this age managed to exist with the crude appliances they had? We think not. There have been some new things but the limit has about been reached in mechanical appliances . . . It is a reasonable assumption that the world will be a still more desirable

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* Technical note: It may be of interest to technical readers that the linkages between primary industries in Montana appear to have declined in importance. Such linkages, once very important, have virtually disappeared as a result of technology and new markets, quite different than the national experience. Careful review of the 1975 Montana I/O tables indicates that primary linkages are much less important than at the national level. This aspect of Montana's economy may in part explain the relative insensitivity of the state to business cycles.

> place of residence at the close of the Twentieth Century than it is at its beginning." [11]

Montana, like nearly everyplace else has undergone extreme change and quickly. Clearly, many of the changes which affect Montana's economy are the result of external events (national, international, climatic, etc.) over which the state has little control. Furthermore, these market and policy changes are perhaps more the rule than the exception. This high degree of uncertainty makes speculation about the future a very unsure business.

Historically, Montana's economic role has been the specialized one of providing raw materials for the national marketplace. As a result of the state's natural resource base, the economy has been largely resource, rather than market oriented, so the importance of manufacturing products for final consumption has been relatively low. In addition to such natural factors, this resource orientation has been partly reinforced by geography and the resultant relatively poor access to national markets. Without any doubt, the resource based industries (agriculture, mining and wood products) have provided the basis for the long term development of the state, and in all likelihood it is these industries which will determine the future of Montana. Concentration in these industries has not been accidental, but rather the result of natural market forces and technology.

A Little History

> "... Montana is a new State in point of settlement and organization, and its multitude of advantages but little known among the millions who occupy the Eastern States, and who seldom reach out for reliable information of this boundless

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[11] K. Ross Toole, Twentieth-Century Montana, A State of Extremes, quote originally from the editorial column, The Daily Missoulian, about 1900.

west. It is said that Montana is new; but a few years since it was a territory; but a few years since it burgeoned from the wild conditions of the frontier to the more civilized occupation of mine and agricultural development." [12]

Most of Montana - east of the Rocky Mountains - was part of the Louisiana Territory, which was sold to the United States by France in 1803. Although the Indians would have known the land well, present day Montana was unknown to the white man until after the Lewis and Clark expedition in 1805. The riches of Montana - furs and other resources - as described in their journals were eyed by mountain men and trading companies as a source of unending wealth. For over thirty years, the Northwest Company and others like it exploited the rich fur country of the upper Missouri and Yellowstone Rivers.

Heavy immigration to Montana came with the discovery of gold in the early 1860's. Bannack, Montana's first territorial capitol, was founded on one of these original discovery sites. The Territory of Montana was created by Congress in 1864 to provide accessible government for the early mining populace - many of them of varied social character making government imperative. By the 1870's, the great placer gold camps had begun to falter requiring a shift to hardrock mining methods, corporate organization, capital improvements, better transportation, and a more orderly business environment.

With this new technology and the coming of the railroads, Montana's population again showed significant gains. Agricultural developments were hastened during this period in response to high prices for food in mining camps and military installations, at least in part related to the cost of transporting food into Montana.

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[12] Sixth Annual Report, Bureau of Agriculture, Labor and Industry, State of Montana, 1898.

Unlike the development of many other states, Montana was urban before it became rural.

As the demand for the products of mining and agricultural enterprises continued to grow - very likely the direct result of the railroads - Montana was to slowly become known as a major exporter of raw materials. Gold, silver, copper and cattle were of particular importance. Population continued to swell through increased homestead and mining activity. And, by 1889, Montana was admitted to the Union as the forty-first state.

Although known as the Treasure State, life was clearly far more difficult during this era than we can probably imagine today. Hardships stemming from vagaries of weather, small land-holding, hazardous working conditions in the mines no doubt left many newcomers worse off than when they left the East.

By the early 1900's, Butte and Helena had population levels of nearly 60,000 and 20,000 respectively. Butte developed a coterie of millionaires and Helena had the reputation of having more millionaires per capita than any city in the world. This was to change since the future of Butte was tied to copper and Helena's to gold. Helena's population continued to decline gradually for several decades until another form of gold was discovered - the public sector. Butte's boom and bust - perhaps a cycle not yet ended - was largely related to technology including copper demand and electric lights (Edison) and the more efficient mining techniques requiring fewer and fewer workers. During this early period, the Anaconda Company "employed more than 13,000 people; amounting to about

three-fifths of the wage earners in the entire state."[13] The technology of the day was to mark one of the darker periods of Montana's economic history - an image or fear which may still be present today.

> "Practically all the vegetation in the town and on the surrounding hillsides had disappeared by 1890. At times the smoke became so thick the citizens literally groped their way around. For days at a time the city would be wrapped in a dense cloud of smoke. Carriages had to be driven slowly for fear of knocking down pedestrians. Railroad engines collided with one another in the switching yards. Trolley cars had to creep through the city ringing their bells constantly; at night the conductors walked ahead of their trolleys with lanterns in their hands. Workers would lose their way going or coming from work." [14]

The Recent Past

The employment data collected by the state dates back to 1947. These data, however, may be suspect for a variety of reasons, but nonetheless provide some interesting comparisons of the changing importance of Montana's industries as shown in Table 3. Table 4 provides the actual levels for the two periods.

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[13] K. Ross Toole, Twentieth Century Montana, A State of Extremes, University of Oklahoma Press, Norman, 1972.

[14] D. MacMillan, Environmental Pollution in Montana, Mountain Press Publishing Company, Missoula, 1972.

TABLE 3

Non Agricultural

Employment Concentration

(1947 - 1977)

	Percent of Total	
	1947	1977
Timber	4.0%	3.5%
Primary Metals	3.0%	1.2%
Food and Kindred Products	3.4%	1.5%
Refining	1.0%	0.4%
Other Manufacturing	1.8%	2.5%
Mining	6.9%	2.3%
Construction	5.3%	5.9%
Transportation and Utilities	16.1%	7.7%
Trade	24.7%	25.1%
Finance	2.6%	4.3%
Services	12.6%	18.7%
Government	18.5%	26.8%
	100.0%	100.0%

Source: Montana Department of Labor and Industry; wage and salary data only.

TABLE 4

Non Agricultural Employment

(1947 - 1977)

(thousands)

	1947	1977	Change
Timber	5.6	9.3	+66%
Primary Metals	4.2	3.2	-24%
Food Processing	4.7	4.0	-15%
Refining	1.4	1.1	-21%
Other Manufacturing	2.5	6.6	164%
Mining	9.6	6.1	-36%
Construction	7.3	15.6	114%
Transportation and Utilities	22.2	20.2	-9%
Trade	34.1	66.3	94%
Finance	3.6	11.4	217%
Services	17.4	49.3	183%
Government	25.6	70.6	176%
Total	138.2	263.7	91%

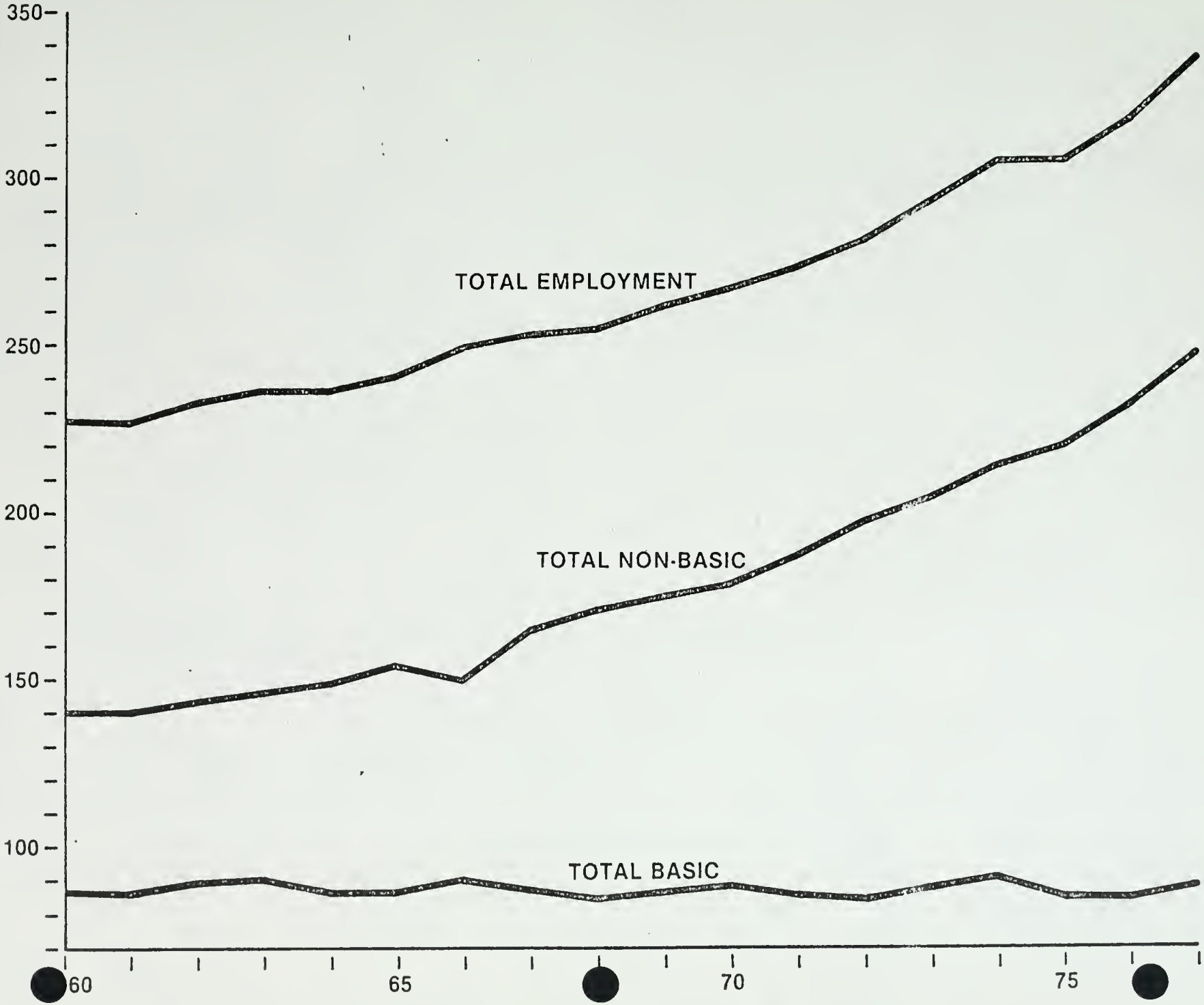
Source: Montana Department of Labor and Industry; wage and salary data only.

Most of Montana's basic industries have declined in relative terms. But, the overall level of employment has remained quite stable. Some sectors such as mining, food processing, and refining have declined but their declines were largely offset by increases in wood products and other manufacturing. The same pattern has also been true since 1960 as illustrated in Table 5 and Diagram 3. The definition of basic and nonbasic employment is, however, somewhat different than the goods and services producing sector comparisons made earlier. Basic sectors include those industries which bring money into the region through exports. That is, they may not necessarily be engaged in the production of physical goods. On the other hand, the nonbasic sectors are defined as those sectors which draw their livelihood from activity in the basic sectors.

Chapter 2 is designed to explore in greater detail how technology has affected (or is likely to influence) specific Montana industries. Other significant influences beyond technology are also considered when appropriate.

DIAGRAM 3

EMPLOYMENT IN MONTANA



Source: Montana Department of Labor and Industry.

TABLE 5

EMPLOYMENT IN MONTANA

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Agriculture	39.0	37.3	38.2	38.3	36.6	35.2	37.1	37.3	33.6	34.1	36.1	35.0	33.1	36.3	38.8	34.8	33.4	35.7
Lumber & Wood Products	7.3	7.4	8.0	8.5	8.4	8.6	8.9	8.7	8.9	8.9	8.2	8.7	9.2	9.8	9.5	8.1	9.1	9.3
Primary Metals	3.8	3.6	3.5	3.2	3.3	3.6	3.9	3.2*	3.7	4.6	4.7	4.1	3.9	3.4	3.4	3.3	3.2	3.2
Food Products	4.3	4.3	4.4	4.4	4.5	4.3	4.3	4.4	4.3	4.3	4.3	4.2	4.2	4.3	4.1	3.5	3.8	4.0
Refining	0.9	1.0	1.0	1.2	1.2	1.1	1.0	1.0	1.0	0.9	1.1	1.0	1.1	1.1	1.1	1.1	1.3	1.1
Other Manufacturing	2.4	2.4	3.5	3.5	2.5	2.9	3.1	3.4	3.6	3.6	3.8	4.1	4.2	4.3	4.5	4.2	4.2	4.6
Metal Mining	4.5	4.2	3.8	4.1	4.8	4.6	4.8	3.2*	2.3*	3.3	4.0	2.9*	3.7	3.8	4.0	3.1	2.4	2.0
Coal	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.2	0.3	0.3	0.4	0.7	0.9	0.9
Non-Metal Mining	0.7	0.7	0.8	0.9	0.9	1.1	1.1	1.0	1.0	0.8	0.8	0.7	0.7	0.8	0.9	0.8	0.6	0.7
Oil & Gas Extraction	2.2	2.2	2.2	2.1	1.9	1.8	1.7	1.7	2.2	2.3	1.8	1.6	1.6	1.6	1.8	1.8	2.0	2.5
Heavy Construction	2.8	4.0	4.7	4.1	4.1	4.5	4.3	4.1	4.9	4.6	4.7	5.1	3.5***	4.0	3.3	3.8	3.8	4.7
Rail Transportation	9.0	8.4	8.1	7.9	7.7	7.5	7.5	7.2	6.9	6.8	6.6	6.4	6.4	6.3	6.5	6.1	6.1	6.3
Federal Government	9.9	10.9	11.5	12.0	11.8	12.1	12.4	12.7	12.3	12.0	11.9	11.9	12.3	12.2	12.9	14.2	13.7	14.1
TOTAL BASIC	**86.8**	**86.4**	**89.7**	**90.2**	**87.7**	**87.3**	**90.1**	**87.9**	**84.7**	**86.2**	**88.0**	**85.9**	**84.2**	**88.2**	**91.2**	**85.5**	**84.5**	**89.1**
Other Construction	8.2	7.3	7.9	8.2	7.3	7.5	7.3	7.6	6.6	5.9	6.3	6.6	7.9	9.0	10.2	8.3	9.7	11.0
Other Transportation	4.0	3.9	3.9	3.8	3.8	4.0	4.1	4.4	4.5	4.6	4.6	5.0	5.1	5.7	6.0	5.6	5.7	6.1
Utilities and Communications	6.0	6.0	5.9	5.9	5.9	6.0	6.1	6.2	6.2	6.2	6.2	6.3	6.4	6.7	7.0	7.3	7.4	7.8
Trade	40.5	39.8	40.3	41.1	41.7	42.9	44.2	44.5	45.5	47.0	48.1	50.1	53.5	56.3	58.8	59.1	63.0	66.1
Services (including publishing)	24.8	25.1	25.7	25.9	26.6	28.0	29.1	30.6	32.3	33.9	35.5	37.2	39.2	42.3	44.3	46.2	49.7	51.4
Finance	6.9	6.8	6.8	6.8	6.9	7.0	7.2	7.2	7.6	7.9	8.1	8.5	9.0	9.4	10.0	10.2	10.6	11.4
State and Local Government	28.6	29.1	29.7	31.0	32.9	33.8	35.7	39.1	41.0	40.1	40.7	42.5	43.1	43.2	45.3	50.7	52.0	56.1
Non-Farm Proprietors	22.8	22.7	23.1	23.5	24.0	24.8	25.7	26.3	26.5	29.8	30.2	31.3	32.6	32.5	32.6	32.6	35.7	38.6
TOTAL NON-BASIC	**141.8**	**140.7**	**143.3**	**146.2**	**149.1**	**154.0**	**159.4**	**165.9**	**170.2**	**175.4**	**179.7**	**187.5**	**196.8**	**205.1**	**214.2**	**220.0**	**233.8**	**248.4**
TOTAL EMPLOYMENT	**228.6****	**227.1**	**233.0**	**236.4**	**236.8**	**241.3**	**249.5**	**253.8**	**254.9**	**261.6**	**267.7****	**273.4**	**281.0**	**293.3**	**305.4**	**305.5****	**318.3**	**337.5**

Sources: Montana Employment Security, Research Division.
U.S. Department of Commerce, Regional Economic Information System.

* Strike
** Recession
*** Libby Dam

CHAPTER II

MONTANA'S MAJOR INDUSTRIES

Agriculture

> The same task which took my grandfather a full day of back-breaking work now takes less than 30 minutes in relative comfort to produce three times the output.

Montana agriculture has undergone substantial change represented by larger and fewer farms, a smaller work force, greater capital inputs, and growing commercialization. The continuing migration of farm labor has effected not only rural areas but urban centers as well. And, to this day, many agricultural areas within Montana are still experiencing out-migration.

This rapid change, largely a product of technology, has had both good and bad effects. Clearly the ability to produce more and more each year has been good for a hungry world but bad for individual farmers and ranchers as a result of unacceptable prices - mirrored by a host of federal subsidies in the 1950's, 1960's, and early 1970's.

Agriculture, like no other industry, is subject to boom and bust cycles. More precisely stated, it is characterized by extreme uncertainty through climatic whim and changes in demand on a world wide basis.

For many years, farming and ranching have employed more people and provided more income than any other basic industry. Since 1920, the high point, agricultural employment has fallen from 38 percent of the employed labor force to slightly under 11 percent today.[15]

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[15] Bureau of Census, 1920; Montana Department of Labor and Industry, 1978.

However, agriculture still remains the dominant economic force of Montana and in all likelihood will continue to be the number one industry in the future.

Some General Facts

Since 1960 overall employment has declined by approximately 11 percent. Physical output measures, however, have shown increases of 16.5 percent in the production of cattle and calves, 64.9 percent in wheat, and 37.2 percent in barley. These represent significant gains but it is suggested that the reader view the data provided in the following tables, since the selection of the base period greatly effects the percentage gains.

Cattle and calf production is measured in total live weight of marketings adjusted for on farm slaughter/consumption, live weight of in-shipments, and inventory changes. Since 1960, there is no stable time trend in output. However, production did increase during the 1960's, and if one assumes that the recent decrease in output was the result of increased culling (the most recent cattle cycle) related to unstable prices, production should again increase when prices stabilize.

Since employment data relating directly to livestock production are not available it is impossible to build a "true" output/employment index for this category. Instead, indices were computed for the total agricultural sector employment based on beef production per animal. This series was developed by simply dividing the production index by the employment index. This yields cattle and calf production relative to total employment based on the 1967 relationship of 1.

Wheat and barley production data, measured in bushels, are

provided as well as the number of acres harvested. Historically, production per acre has increased. Part of the increase was probably due to favorable moisture conditions for the last several years of the series. However, some of the increase can be attributed to improved procedures as well as improved strains. This technological assumption is the primary reason for projected increases.

Three-year averages of yield per acre were developed for both wheat and barley. The historical growth rates are assumed to remain constant over the entire period, 1977-2000. This assumption results in increased wheat yields from 26.5 bushels per acre in 1980 to 30.0 in the year 2000. These projections are consistent with both the Montana OBERS series and national forecasts prepared by Chase Econometrics, Inc.

Wheat and barley indices were prepared exactly as the livestock indices discussed earlier. Again, caution is necessary since the ratios reflect past weather patterns and prices. These problems are obviously carried forward.

TABLE 6

Montana Agricultural Output

	Cattle and Calves		All Wheat		Barley	
	Production (000 lbs.)	Number[1] (000 head)	Production (000 bu.)	Harvested (000 acres)	Production (000 bu.)	Harvested (000 acres)
1960	789,875	2245	79,397	4088	40,444	1721
1961	742,180	2155	54,048	4262	26,370	1465
1962	737,845	2133	79,332	4248	54,961	1802
1963	828,865	2325	92,294	4246	44,663	1514
1964	927,420	2672	93,752	4156	49,692	1529
1965	948,420	2758	105,350	4551	50,050	1300
1966	985,385	2841	99,694	3885	63,564	1651
1967	973,940	2869	119,136	4825	37,022	1255
1968	1,062,930	2984	125,869	4722	42,735	1155
1969	1,066,560	2984	99,754	3920	67,914	1617
1970	1,089,015	3014	85,167	3506	65,132	1714
1971	1,122,103	3165	112,011	4516	58,800	1680
1972	1,103,350	3165	98,831	4130	64,013	1707
1973	1,053,550	3197	93,714	4235	60,000	2000
1974	1,035,930	3380	120,108	5020	37,120	1280
1975	963,050	3340	155,925	5130	50,700	1300
1976	974,090	3150	167,295	5415	52,065	1120
1977	920,820	2980	130,920	5060	55,480	1520

[1] Inventory beginning of year

Source: Montana Agricultural Statistics, Montana Department of Agriculture.

TABLE 7

Montana Agricultural Employment and Output Indices
(1967 = 100)

	Employment		Cattle & Calf Production		All Wheat		Barley	
	Number	Index	Per Animal	Index	bu/acre	Index	bu/acre	Index
1960	39.0	104.6	351.8	103.7	19.4	78.5	23.5	79.7
1961	37.3	100.0	344.4	101.5	12.7	51.4	18.0	61.0
1962	38.2	102.4	345.9	101.9	18.7	75.7	30.5	103.4
1963	38.3	102.7	356.5	105.0	21.7	87.9	29.5	100.0
1964	36.6	98.1	347.1	102.3	22.6	91.5	32.5	110.2
1965	35.2	94.4	343.9	101.3	23.2	93.9	38.5	130.5
1966	37.1	99.5	346.8	102.2	25.7	104.0	38.5	130.5
1967	37.3	100.0	339.4	100.0	24.7	100.0	29.5	100.0
1968	33.6	90.1	356.2	104.9	26.7	108.1	37.0	125.4
1969	34.1	91.4	357.4	105.3	25.5	103.2	42.0	142.4
1970	36.1	96.8	361.3	106.5	24.3	98.4	38.0	128.8
1971	35.0	93.8	354.5	104.4	24.8	100.4	35.0	118.6
1972	33.1	88.7	348.6	102.7	23.9	96.8	37.5	127.1
1973	36.3	97.3	329.5	97.1	22.1	89.5	30.0	101.7
1974	38.8	104.0	306.5	90.3	23.9	96.8	29.0	98.3
1975	34.8	93.3	288.3	84.9	30.4	123.1	39.0	132.2
1976	33.4	89.5	309.2	91.1	30.9	125.1	44.5	150.8
1977	35.7	95.7	309.2 E	91.1	25.9	104.9	36.5	123.7
1980	35.0	93.8	350.0	103.1	26.5	107.3	36.0	122.0
1985	34.0	91.2	350.0	103.1	27.4	110.9	37.0	125.4
1990	33.0	88.5	350.0	103.1	28.3	114.6	38.0	128.8
1995	32.0	85.8	350.0	103.1	29.1	117.8	39.0	132.2
2000	31.0	83.1	350.0	103.1	30.0	121.5	40.0	135.6

Source: Developed from the preceding table.
Employment data from Montana Department of Labor and Industry.

Projections: Western Analysis, 1978.

TABLE 8

Farm Size

	Number	Total Acreage	Average Size
1960	31.7	66,700	2,104
1965	28.4	66,700	2,349
1970	26.4	64,200	2,432
1972	25.5	63,200	2,478
1974	24.6	62,800	2,553
1976	23.7	62,400	2,633
1978	22.9	62,100	2,712
Change	-27.8%	-6.9%	28.9%

Source: Montana Agricultural Statistics.

TABLE 9

Montana Agricultural

Output/Employment Ratios

	Cattle & Calf Production	All Wheat Production	Barley Production
1960	99.1	75.0	76.2
1961	101.5	51.4	61.0
1962	99.5	73.9	101.0
1963	102.2	85.6	97.4
1964	104.3	93.3	112.3
1965	107.3	99.5	138.2
1966	102.7	104.5	131.2
1967	100.0	100.0	100.0
1968	116.4	119.9	139.2
1969	115.2	112.9	155.8
1970	110.0	101.7	133.1
1971	111.3	107.0	126.4
1972	115.8	109.1	143.3
1973	99.8	92.0	104.5
1974	86.8	93.1	94.5
1975	91.0	131.9	141.7
1976	101.8	139.8	168.5
1977	95.2	109.6	129.3
1985	118	133	150
1990	123	148	165
1995	127	162	182
2000	131	179	201

Source: Developed from the preceding table.
Projections by Western Analysis.

Projections

The most recent output projections (1978) for Montana agricultural products were developed by Dr. John Marsh, Dr. Won Koo and Dr. Jim Cornelius, all of Montana State University. These projections for wheat, barley, and beef were developed using ordinary least squares procedures with a variety of independent variables, i.e., price, income, national population, etc.

The projections, shown below, depict steadily rising output levels through the year 2000.[16]

TABLE 10

Output Projections

	Beef 1000 head		Wheat (000 bu.)	Barley (000 bu.)
1960	2245		79,397	40,444
1965	2758		105,350	50,050
1970	3014		85,167	65,132
1975	3340		155,925	50,700
1985	3247	1985	137,568	55,845
1995	3583	1990	148,358	56,679
2005	3946	2000	168,438	61,309

Source: J. Marsh, W. Koo, and J. Cornelius, Projected Demand and Supply for Montana Red Meats and Grains, Montana State University, 1978. (All projections represent the average of a low and high scenario.)

When the output projections are combined with the productivity projections (See Tables 7 and 8.) the result is slightly declining total employment levels but at a rate much lower than in the previous decades. Table 11, provides such a comparison.

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16 J. Marsh, W. Koo, and J. Cornelius, Projected Demand for Montana Red Meats and Grain, Montana State University, 1978.

TABLE 11

Projected Employment Levels

1960	39.0
1965	35.2
1970	36.1
1975	34.8
1985	34.0
1990	33.0
1995	32.1
2000	31.0

Source: Western Analysis.

Productivity Change Slowing?

The employment, output, and productivity projections which were just presented are "largely" the result of smoothed time trends. The assumption is that the pattern experienced during the past two decades will continue for the next two. As a result, these projections should not be interpreted in an overly precise manner. Production and employment will no doubt continue to experience extreme year to year fluctuations as a result of weather, prices, measurement, and changes in federal policies. Simply stated, the assumptions of significant increases in yield, mechanization, and managerial capacity are subject to considerable debate.

The national growth in carrying capacity of the farmer/rancher (people per farm worker) has slowed significantly since the mid 1960's. Changes in production technology have resulted in a larger proportion of our meat supply being produced from products of cultivated land rather than from grazing. The precipitous rise in dogs, cats, riding horses, and other pets creates an additional demand for food which is directly competitive with man. Again, on the national level, much of

the increase in crop yield can be associated with increasing fertilizer use, especially nitrogen derivatives. Yield rose continuously, but at a declining rate as nitrogen became cheaper in real dollar terms. Since 1974 the real price of fertilizer has dramatically changed. Furthermore, it is unlikely to decline but rather significantly increase. In livestock, gains in feed efficiency have been slight. These growth rates may suggest some early warning signals for future gains in agricultural productivity.[17]

Other potential constraints include energy availability and price and concern over current technological practices, i.e., environmental impacts. These two potential areas of concern represent the most frequently sited factors influencing new technology.[18] The overall energy input to the food system has risen nearly eight times as fast as the food energy consumed. Rising energy costs are likely to affect this pattern and perhaps yields.[19] In addition, increasing concern over environmental issues (fertilizer and pesticides, diminishing land base, etc.) may very well result in less capital intensive production techniques as we know them today. Biological limitations - the physical limit of plants and animals to produce exists - may also be reached constituting an impenetrable barrier to technology.

A Look Ahead

On a more positive note, other individuals and groups suggest that

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17 National Academy of Sciences, Agricultural Production Efficiency, 1975.

18 Office of Technology Assessment, Emerging Food Marketing Technologies, 1977.

19 American Association for the Advancement of Science, Food Politics, Economics, Nutrition and Research, 1975.

the agricultural revolution may just be beginning. For example, a study of agriculture in the United States, suggests that within the next generation wheat yields could be increased to over five times the present average and that hormone control of ovulation and pregnancy cycles of cows (through implantation in breeder animals) may result in substantial increases in a herd's prolificacy and quality.[20]

There still exists a significant potential to boost yields as shown in the following table. However, the question is not so much - does the technology exist but rather is it economically viable?

TABLE 12

Average and Record Yields

	Average 1974	Record	Record/ Average
Corn (bushel per acre)	72	307	4.3
Wheat (bushel per acre)	28	216	7.7
Soybeans (bushel per acre)	24	110	4.6
Sorghum (bushel per acre)	45	320	7.1
Oats (bushel per acre)	48	296	6.2
Barley (bushel per acre)	38	212	5.6
Potatoes (bushel per acre)	420	1400	3.3
Sugar Beets (ton per acre)	19	54	2.8
Milk production per cow (10^3 pounds)	10.3	50	4.9
Eggs per hen	230	365	1.6

Source: American Association for the Advancement of Science.

Scientific groups concerned with priorities in food and agricultural research are agreed that the returns from a long-term program of expanded basic research are likely to be great, although additional investments in a wide variety of projects are needed.

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20 G. Gregory, United Nations Educational, Scientific, and Cultural Organization (UNESCO), 1969.

An increase in the efficiency of photosynthesis in crops could result in a 50 percent increase in yield per acre. The annual value of increased production, reduced acreage, and/or production costs would amount to no less than $1 billion assuming this increase of only 50 percent in the yield of soybeans in the United States.

Improvement in nitrogen fixation in legumes also would result in large gains. A 10 percent increase in soybean yield has been reported in the last few months where improved nitrogen-fixing bacteria have been utilized in producing the crop. An even greater gain would be achieved with the development of symbiotic nitrogen fixation in corn, cereal grains, or any important crop other than legumes. Such a discovery could reduce the need for nitrogen fertilizer by millions of tons per year in the United States and throughout the world. A saving of half a billion dollars a year in the United States for nitrogen fertilizer is not an unrealistic expectation.

Cell-culture studies offer promise for developing new combinations of germ plasm and thus provide a means for genetic engineering which could lead to new strains of Rhizobium with much higher nitrogen-fixing capacity. They could also lead to new varieties of soybeans, cereals, potatoes, and other crops with substantially higher photosynthetic efficiency levels than occur in conventional plant-breeding methods.[21]

Changes More Specific to Montana

While the number of irrigated acres has increased (7%) over the last decade, the proportion of output from irrigated land to the total

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[21] Office of Technology Assessment, Organizing and Financing Basic Research to Increase Food Production.

crop has remained unchanged.[22] Furthermore, within the last few years the acreage has declined somewhat, possibly a reaction to lower grain prices. This slow growth is not particularly encouraging. In addition, only small improvements in irrigation efficiency associated with current practices are expected to occur in the future. Widespread application of new technology to achieve significant increased irrigation efficiency will be stifled without changes in water rights distribution or major public program incentives.[23]

With respect to the actual land base, total land under cultivation has increased approximately ten percent within the last ten years. This increase has no doubt been responsible for a significant amount of the total gain in output. And, there is increasing concern over the long range effects (erosion) of converting more and more protective grass land into intensive uses. Land-using technologies, particularly on marginal land could present real problems in the future.

There is also increasing concern over the accelerating use of nitrogen and its effects on water quality and recreational values.[24] Also, indices of soil quality (national) by the National Wildlife Association indicate substantial declines since the index was developed in 1969. Unfortunately, such a comparison for Montana is not available.

Montana agricultural practices are expected to become more mechanized - a continuation of the long term of substituting labor for

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22 Montana Department of Agriculture, Montana Agricultural Statistics, 1978.

23 United States Department of Agriculture, National Water Assessment, 1975.

24 Resources for the Future, Environmental Considerations in Expanding Agricultural Production, 1976.

capital and ever increasing farm size. Since 1967, survey data reveals that the number of tractors per operator has continued to increase. The most significant changes occurred in the number of large units (300 PTO horsepower).[25] New, even larger four wheel drive units are expected to rapidly grow in importance. Part of this potential growth may be the result of less managerial problems, i.e., it is easier to manage machinery than people.

Another potential technical change which may affect Montana is the increasing feasibility of ethanol from grain. Opinions surrounding the viability of synthetic fuel from grain (or other inputs) are extremely divergent. However, a major increase in the real price of gasoline may push this form of technical change from feasible to practical.

In all probability, the single most important factor influencing technical adoption and output will be the overall level of world demand, including the ability to pay. But, again the opinions often point in different directions. Rising population, particularly in developing countries, may more than triple the export demand within the next decade.[26] The debate, however, does not surround the need to produce; but rather the ability to maximize output to meet the rising need. Furthermore, long term declines in food reserves (world wide) and the more current downturn in worldwide grain output per hectare will continue to place a greater emphasis on U.S. and Montana ability to produce.[27]

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25 R.C. Greer, Changes in Farm Size and Machinery Use, Montana State University, 1977.

26 World Food Conference, Rome, 1975.

27 The World Food Prospect, Science, 1976.

Agricultural production needs a quantum jump. The urgency of this need is multiplying pressure for a massive research effort on agricultural productivity. But before any all out efforts can be made, the price must be right - in other words, the ability of foreign countries to buy and U.S. producers to supply (at a profit) must be in phase. U.S. food production and the power that it embodies may eventually become a weapon in world politics.

There is little disagreement that Montana agriculture will continue to grow. The real question is - how much? The duplication of twentieth-century spectacular productivity breakthroughs, however, may not be repeated.

THE WOOD PRODUCTS INDUSTRY

The growth of the wood products industry was also closely associated with the development of mining. That is, underground mines needed timbers and miners needed lumber to build homes. As mining and smelting activities expanded, the lumber industry expanded in step. By 1900, the industry employed over 2400 workers and was the only manufacturing activity in Montana of any consequence.

Many of the original mills did not survive the decline of the gold camps. However, new demands including railroad construction kept this young industry growing. Railroads were to play an especially important role, acquiring large holdings of timber as land grants or through actual purchase.[28]

During this infancy stage, timber was cut where it was found.

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[28] Bureau of Business and Economic Research, Montana Economic Study, University of Montana, 1970.

Gradually restrictions on commercial cutting on government land began to evolve, (Timber and Stone Act, Free Timber Act); suits were filed for violations, but actual practices remained much the same.

At the turn of the century lumber production amounted to approximately 250 million board feet per year, about 20 percent of the current level. However, variations in yearly output particularly following the depression were extreme. Logging activity declined to less than 30 percent of the 1930 level as the national business climate and construction volume continued to worsen. Between 1929 and 1933 lumber related employment fell from 3925 to 1329.[29]

In addition to cyclical fluctuations, this industry has also been subject to significant seasonal changes in employment and still is, but to a somewhat lesser degree than during its development stage. The effects of snow, rain, cold, and frost continue to result in a 20 percent average employment variance over the course of a year, resulting in higher than average unemployment rates in those counties based on lumbering.[30]

After World War II, the tremendous increase in construction activity insured a continued demand for Montana wood products. This postwar increase was also related to declining timber supplies in other parts of the nation. Producers began to view Montana's resources, which to this point had not been fully utilized, with more interest. Rising prices and improved technology in terms of

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29 Bureau of Business and Economic Research, Montana Economic Study, University of Montana, 1970.

30 Western Analysis, Unemployment in Montana, Working Paper #3, 1978.

harvesting steep slopes gave birth to numerous small mills during this period. However, this postwar boom was relatively short lived. Between rising interest rates, mortgage constraints, and the falling demand for mine timbers (i.e., shift to open-pit mining) the industry experienced a sharp reduction in output and employment. But within a few years the industry regained stability and became more diversified through pulp, paper, and fabricated products.

As prices for lumber products continued to rise, a strong market developed for residuals from the existing industry. These technical innovations not only expanded employment but improved the efficiency of the entire system. That is, many of these new products were produced using by-products of other firms which were previously burned or disposed of by other means. Other advantages included less seasonal fluctuations in employment and another income source (sale of chips) to the mills.

Increasing national demand for plywood because of a shortage of logs for plywood in other areas, also helped Montana's industry to grow. Mills were increasingly modernized and new products were added such as laminating, paneling, finger-jointing, pressed logs, and studs, which can be made from smaller trees. Many of these new technologies and products were the result of or in reaction to rising prices, increasing shortages, and growing demand - of course, all related.

Table 13 provides employment and production data since 1960. Several facts should be pointed out. First, employment and output reached a peak in 1973 at the same time when national construction activity was at an all time high. The 1974 housing crash related to the combination of high lumber prices, record interest rates, and

TABLE 13

Montana Lumber Employment and Output

	Employment (000's)	Employment Index	Production Board Ft.*	Production Index
1960	7.3	83.9	1035	76.8
1961	7.4	85.1	1152	85.5
1962	8.0	92.0	1259	93.4
1963	8.5	97.7	1166	86.6
1964	8.4	96.6	1271	94.4
1965	8.6	98.8	1311	97.3
1966	8.9	102.3	1375	102.1
1967	8.7	100.0	1347	100.0
1968	8.9	102.3	1499	111.3
1969	8.9	102.3	1397	103.7
1970	8.2	94.3	1281	95.1
1971	8.7	100.0	1397	103.7
1972	9.2	105.7	1311	97.3
1973	9.8	112.6	1445	107.3
1974	9.5	109.2	1165	86.5
1975	8.1	93.1	1038	77.1
1976	9.1	104.6	1197	88.9
1980	9.5	109.2	1200	89.1
1985	9.8	112.6	1250	92.8
1990	10.0	114.9	1250	92.8
1995	10.0	114.9	1250	92.8
2000	10.0	114.9	1250	92.8

*note: The production figure is measured in millions of board feet of cut lumber and does not include processed materials.

Source: Western Wood Products Association, Portland, Oregon. Projections by Western Analysis, 1978.

sharp credit reductions, dealt a severe blow to the industry for several years. The national recession immediately following the housing decline also helped to keep the market depressed. Since then employment and output have increased but not to the 1973 level. Second, most of the employment growth occurring in this sector has not been the result of increasing logging activity but as a result of new product development. The relationship between output (as measured in millions of board feet) and employment has been steadily changing, requiring relatively more workers for a given amount of physical inputs. By no means does this imply that the industry is becoming less efficient but rather that the product mix is changing in favor of processed materials rather than dimension lumber. However, there may have been some slight declines in production efficiency, crudely measured as board feet cut per logger. Within the last fifteen years, this measure of output per worker has fallen by approximately 20 percent. This presumed decline may reflect several related events. Specifically there are fewer large trees, new areas of development are increasingly more costly (slope, accessibility, etc.), the mix of harvest between private and public lands has changed and so has Forest Service policy - more restrictive. Logging technology has improved (saws, trucks, other equipment) but technological advance does not always ensure increasing output levels per logger. This aspect of technological change combined with new products has resulted in more jobs, not less.

Current Issues

This industry is used to market uncertainty. Changes in national demand and the resulting boom and bust cycle have been and will remain a fact of life. However, the long term future of the industry is much

more related to changes in management policy - a form of technology - than to national demand. The U.S. Forest Service, currently in the limelight, will be making decisions which will significantly affect timber practices. The Roadless Area Review and Evaluation Process and the National Forest Management Act (1976) represent two major decision points. However, it should be stressed that these two "issues" are only part of a continuing process. That is, all planning processes are subject to change when warranted.

RARE II represents the most hotly debated topic in Montana today. It is an emotionally charged issue with comments from both factions (pro development, environmental) often making equal sense but being totally divergent. In addition to the problems associated with polar extreme viewpoints, the problem is magnified by uncertainty and poor information (data). The industry is arguing that excessive or poorly selected wilderness areas will result in job loss in the future. They are right, but the question is how many jobs will be lost. Environmental concern for noncommodity values is, however, important. But, the argument goes much deeper than simple wilderness and nonwilderness distinctions but to the pressing need for good management of both public and private forest lands in the future. The RARE II process, apparently the result of a frustrated Congress and going sentiment over the ability of the Forest Service to manage, merely helped to make the issue more publicly visable. And, in all probability the RARE II issue, if ever resolved, will not by itself determine the future of either commercial growth/decline or environmental quality. It is difficult to even reveal the real arguments with clarity.

The Environmental Side

"Americans were using more and more wood each year, and the supply was not keeping up with the demand. Result: there was tremendous pressure to increase harvests on 90 million acres of national forests.

The timber industry was accustomed to having its own way in the woods, but there were signs that other forest users would have much more to say in the years ahead. We must recognize that growing the most timber on the least land in the shortest time does not always contribute to our environmental quality. One of the greatest assets of our forests is the role they play in water conservation. They also have important recreational and wildlife values.

Those values were central to many of the conflicts that were brewing over U.S. forests. Increasingly, people were challenging the old practice of clear-cutting - felling every tree in a given area - partly because of its effect on wildfife. There were demands for more ski lifts in national forest, more hunting access, more campsites and hiking trails. Meantime, the old forest problems continued: stream siltation from logging, wasteful harvesting practices, forest pests, destructive fires, and of course, the mounting demand for timber."[31]

In view of the environmental arguments, it appeared as if the best or only way to protect any area with special qualities was to make it a wilderness. Wilderness is important, but of course can not be measured on a commodity basis unless defined in terms of the cost of jobs or income foregone, a very speculative measure at best.

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[31] National Wildlife Federation, National Wildlife, 1979.

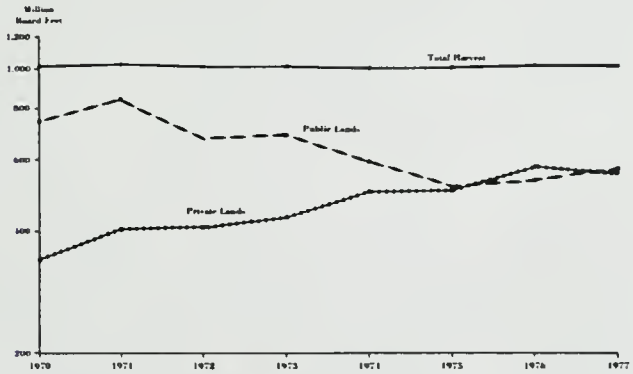
The Industry Side

Over the long run what happens to the forest industry is directly related to what happens to the supply of public timber. In 1970 and 1971 public timber amounted to approximately two-thirds of the harvest, the rest coming from private lands. However, within a few years the pattern of public and private harvest significantly changed, placing relatively less emphasis on public lands and more on private. Diagram 4 depicts this change.

DIAGRAM 4

TIMBER HARVESTED FROM PUBLIC AND PRIVATE LANDS IN MONTANA 1970-1977

Ratio Scale



SOURCE: U.S. Forest Service, Region 1, unpublished data (Missoula, Montana).

NOTE: Public lands include federal lands administered by the Forest Service and Bureau of Land Management; Indian forestlands managed by the Bureau of Indian Affairs; and state forestlands managed by the Montana Department of Natural Resources, Division of Forestry.

The allowable cut on public land has been much higher than the actual since the early 1970's. This "may" have resulted from RARE II, RARE I, or possibly other actions on the part of the Forest Service which resulted in a more conservative cut. Or, it may simply have

been a matter of arithmetic - the way in which the allowable cut was calculated. Regardless of the cause, the effect was to shift the burden of harvest to private lands, which are often not well managed.

The total timber harvest was maintained by a substantial increase in the harvest on private lands. Most of the private timber land, however, is owned by a few large firms. Many other producers are wholly dependent upon public timber.

The great concern of the industry is that further reductions in the supply of public timber may occur. At the present time, some 6.5 million acres of national forest lands and grasslands are currently under review for possible designations as wilderness areas.

The industry regarded RARE II as another administrative delay creating substantial uncertainty over supplies and potential job loss. This uncertainty and clear irritation was probably compounded by the fact that the final decision would have little if any direct effect on the decision markers. In other words, the actual impact would be felt locally, not nationally. Their fears may have been partly reduced, however, by the recent Forest Service Wilderness recommendations which have limited commercial conflict. This action was regarded as a sell-out by environmental groups. And, the whole process probably regarded by professional land managers (Forest Service) as a slap in the face.

National Forest Management Act

One of the more controversial aspects of the National Forest Management Act (NFMA) of 1976 is the so-called marginal lands provision, section 6 (k). It requires the secretary of agriculture to identify lands within the management area which are not suited for timber

production and, in general, to assure that no timber harvesting shall occur on such lands for a period of 10 years. The Forest Service is currently struggling with criteria for identifying marginal lands. So is the Committee of Scientists, authorized in NFMA to provide advice to the Forest Service on guidelines and procedures for implementing section 6 (g) of the act, which concerns land-management planning and guidelines for management of the national forest.

The legislative history shows a clear and substantial difference between the House and the Senate on the marginal lands issue. The intent of the Senate provision was to stop harvesting on lands unsuited for timber production. The test of suitability was to be an economic one. The House precursor to NFMA had no comparable provision.[32]

This may pose a further threat to the timber supply in Montana, on the grounds that Montana's steep mountainsides are not physically suited to timber harvest and/or that they are marginal producers compared to forests in other parts of the country. In other words, investment in national forests presumably is to be allocated to areas where the relative effects on environmental quality are the smallest and the potential return on investment is the highest.

This particular issue is probably of far greater long run significance than RARE II. If standards are set sufficiently high, a substantial amount of de facto wilderness may be created - ironically encompassing many of the disputed RARE II areas today.

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[32] The Marginal Lands Provision, Journal of Forestry, January 1979.

Long Range Projections

The employment and harvest projections found in Table 13 are no more than trend with a little judgment. Employment is assumed to gradually increase since national demand for housing is expected to remain strong for the next decade. Specifically demographic patterns - the large number of now young adults born in the 1950's - should help maintain a high level of new household formations. But, it is likely that most of the employment increase will continue to be found in processed materials as opposed to employment in actual logging or the milling of dimension lumber.

However, the timber harvest is likely to remain at about the present level or possibly decline slightly. New wilderness area designation or the National Forest Management Act will probably limit any growth beyong the present harvest. The settlement of RARE II will nevertheless release several million acres of timber for possible commercial use but it is unclear whether or not it will be immediately sold. The demand on the part of the industry may not exist or further regulations could curtail the extent of leasing. Several individuals have suggested the settlement may result in more liberal sales after the uncertainty is lifted for both the Forest Service and the industry. Other experts contend that sales will continue to be conservative - well below the sustained yield level.

In addition to management regulations, there are several other important factors which may influence the harvest. First, if relative wood prices continue to rise as fast as they have in the last five years, consumer demand will decline at least in a relative sense. Second, timber output in the South may result in Montana loosing

its present share in the national market. The extent to which Southern timber is less expensive than that of Montana will determine the shift. Southern timber growth rates are higher than the growth in Montana, but then again the type of lumber is different. It is likely that consumers will be faced with price/quality trade-offs between traditional and new building materials.

In view of these qualifications, a range of projections is probably appropriate. The projections are shown below.

TABLE 14

Timber Harvest
(millions of board feet)

	Best Case	Worst Case	Average
1980	1396	1072	1234
1990	1355	993	1174
2000	1315	957	1136

Source: Adapted from Polzin, 1978.
U.S. Forest Service, 1977.

Regardless of the actual level, it is doubtful that the present rate of harvest on private lands can be indefinitely maintained. Current rates of logging are well above historical averages and management practices generally low aside from a few firms which are more advanced than the Forest Service. Beyond these select firms, it is likely that there will be a greater reliance on public lands for timber supply than the present situation.

Technology and the Future

"Intensive, high-yield forestry - is still an experimental intervention in an ecosystem that has been evolving for millions of years. Despite the achievements that high-yield forestry represents, it is well to exercise caution before extending it to the public lands - for we have paid again and again for the misplaced certitude of experts."[33]

There is little dispute by industry experts that productivity on federal lands could be increased greatly through intensive forestry - artificial planting, control of competing vegetation, fertilization, thinning and breeding of new genetic strains. The Forest Service admits that the land under its management produces 50 percent less wood fiber per acre than industry-owned lands and with respect to best practice industry land - much less.

The technology exists but is not employed for several reasons. The budget may not be sufficient which forces the Forest Service into the position of selling trees and not developing improved technology. There is also resistance from pressure groups who for good or poor reasons oppose intensive management. In 1970, the Public Land Law Review Commission tried to alter the concept of "multiple-use" by recommending that some public lands be used only for timber production, switching to high yield practices. The idea was promptly dropped due to environmental concern over the tendency to favor monoculture: to promote extensive stands of single species of the same age. The basic argument was that diverse ecosystems are much more resistant to attack

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[33] R. Peterson, Chairman, Council of Environmental Quality, Sixth American Forest Congress, 1976.

(insect, fire, etc.) than pure strains. Modern agriculture depends on monoculture rather than volunteer crops of whatever comes up naturally. The primary problem is one of timing. If a blight or pest shows up in a corn field and can not be controlled only one crop is lost - just a year. The same problem in an entire forest may result in a 80 year mistake. Nevertheless, multiple use of any land system ultimately involves trade-offs; at some point timber harvest must be purchased at the expense of other valves or potential risks.

The technology exists to help meet timber demand - perhaps double yield - but, the real cost and gain is difficult to measure.[34] Private firms will probably adopt new technology much faster than the forest service for several reasons - they have no choice and there is much less resistance since they assume the risk. Public land decisions are more complex and certainly more time consuming . . . with tongue in cheek, hopefully less time consuming than a new growth cycle.

Dead, dying, diseased, and down timber harvests also present problems - opening up new roads, reducing wildlife habitat but reducing the potential for fire disaster. In addition, accelerated management generally goes hand in hand with stepped up use of herbicides and pesticides once again altering the natural process. There are quite simply no easy choices . . . everything has a price.

Aside from these more serious environmental/commercial trade-offs several other possibilities exist to stimulate production. For example, the American Plywood Association has developed a new construction material made of the ground-up particles of the inner part of a log; this process has the potential of doubling the usable wood products

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[34] Intensive Reforestation, Comptroller General, 1974.

derived from a tree. Another Forest Service project, the Sawmill Improvement Program, has documented increases in production of 13-28 percent through improved sawing and milling techniques. The study involved mills in Idaho and Montana with a combined annual lumber production representing approximately one-third of the 1975 production for Montana and Idaho.[35]

In addition to new technology designed to utilize smaller diameter trees it is likely that more portable machinery will be developed extending the limit and type of potential harvest areas. Also helicopter, balloon, and horse logging may increase in areas where environmental regulations may constrain the use of traditional techniques.

There also exists some potential to expand particle board or pulp production in the future. However, wood residual input supply is currently short, i.e., limited by the output of existing mills. But as wood residue becomes more scarce, and as technology improves, it may become feasible to use today's submerchantable material - forest residue.[36] Other possible uses for residue include pelletized fuel - a potential currently being explored within Montana.

THE MINING INDUSTRY

The Montana State Seal appropriately presents the words, "oro y plata," as well as the tools of a miner. To this day, mining, Montana's first manufacturing industry, still remains the largest.

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35 U.S. Forest Service, Sawmill Improvement Program, 1976.

36 Bureau of Economic and Business Research, Forest and Mill Residue in Montana and the Potential for Major Manufacturing Plants, University of Montana, 1978.

However, mining and the processing of mineral products no longer play the overwhelming role of earlier days. But, after decades of employment declines, mining is currently the fastest growth industry in Montana, and future prospects for expansion look good.

Gold exploration and extraction gave birth to the industry but rapidly lost its dominance to silver, then later to copper. The mining and processing of copper still remain the largest employment category with approximately 35 percent of overall mining employment. Oil and gas related employment is an extremely close second, followed by primary aluminum and coal. Most of the remaining jobs in this sector are provided by numerous small operations producing sand and gravel, phosphate, fluorspar, talc, bentonite, and other nonmetallic minerals. This other category currently employs about 8 percent of the total.

Both the overall employment level and the inter-industry mix of employment have undergone dramatic change. In 1909, there were nearly 27,000 employees engaged in mining or related activities, representing 15 percent of total employment within Montana. The most current information indicates an employment level of approximately 10,400 or 3 percent of statewide employment. Table 15 provides comparison data since 1950.

Until 1950 metal mining employment was significantly larger than any other category. But since the mid 1950's substantial losses have occurred in this sector, amounting to over 6000 jobs. And since these were jobs that paid wages well above the Montana average, this was a serious loss for the state, particularly in the Anaconda and Butte areas. The population of Butte, for example, has declined over

TABLE 15

Distribution of Mining Employment

	1950	1955	1960	1965	1970	1977
Metal Mining	51.0%	48.0%	37.2%	37.7%	32.3%	19.2%
Primary Metals	26.1%	24.6%	31.4%	29.5%	37.9%	30.8%
Oil and Gas *	15.0%	22.3%	25.6%	23.8%	23.4%	35.6%
Other	7.8%	5.1%	5.8%	9.0%	6.4%	14.4%
Total Employment	15,300	17,500	12,100	12,200	12,400	10,400
Metal Mining	7,800	8,400	4,500	4,600	4,000	2,000
Primary Metals	4,000	4,300	3,800	3,600	4,700	3,200
Oil and Gas *	2,300	3,900	3,100	2,900	2,900	3,700
Other	1,200	900	700	1,100	800	600
Coal	N/A	N/A	N/A	N/A	N/A	900

* Note: includes refining

Source: Montana Department of Labor and Industry

30 percent since 1950. Overall county employment has declined since 1970 and unemployment rates have nearly doubled since the closing of underground mining operations in 1975.[37] This city has experienced the adverse effects of technology, perhaps as much as any area in the country.

Metal mining activity (employment and production) has always been very sensitive to national and world markets. Rising foreign competition and outmoded technology have resulted in extreme uncertainty. However, prospects for improvement seem to be favorable.

Primary metals employment has also declined, largely as a result of the modernization of plants. The only "new" facility (1955) is the Anaconda Aluminum plant located at Columbia Falls. This facility located near the Hungry Horse Reservoir was developed largely because of inexpensive power. However, with the proposed changes in BPA rate structure, this plant may be in danger. The firm's input costs are geared toward cheap power and a doubling or tripling of rates may result in a tight profit squeeze. Furthermore, the economy of the area is closely associated with the future of the operation; 1300 direct jobs. In order to reduce potential impacts, the firm is rapidly incorporating more energy efficient processes.

Oil and gas employment has remained quite stable since the late 1950's. Variations in this sector have been for the most part related to exploratory and extraction activities. Refinery employment in Yellowstone County has not changed significantly for years. Canadian export policy or pipeline development will in all probability determine

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[37] Western Analysis, Butte-Silver Bow Development Plan, 1978.

the future of these firms since they are heavily reliant on imported crude stock. Recently, exploration and leasing activity has taken a sizeable jump paricularly in the Shelby and intermountain areas. Potential for development of the "overthrust belt" along the Rockies may be significant, given sizeable finds in Utah and Canada. The recent oil price hikes may also stimulate interest in this region, once federal leasing policy is stabilized, and RARE II resolved.

Other forms of nonmetallic mining activity have generally been stable. Potential development prospects in this sector are discussed later. Clearly, coal production has not followed this pattern. Coal has increased from virtually nothing in 1970 to an important and expanding sector of Montana's economy. One only needs to look at employment and population patterns in southeastern Montana to determine the significance - good or bad - of this change.

Important Linkages - Metal Mining

During the peak production years (1973/1974) copper output per employee (statewide) was 34 tons per man. Currently output is about 43 tons per man. Since 1973 Montana output has fallen about 30 percent, but employment in the industry is off by nearly 50 percent. In other words, employment has declined much faster than mining activity. This was, no doubt, the result of the closing of underground operations in Butte and the associated increase in efficiency, i.e., output per man. It is unlikely that such rapid technological changes will occur in the future.

The Anaconda Company, now owned by Atlantic Richfield, operates three other major plants within Montana. These include a smelting operation in Anaconda (25 miles west of Butte) and a refining

facility in Great Falls (150 miles north of Butte). Both the Anaconda and Great Falls operations are directly linked to Butte, receiving partly processed ore from the Berkeley mine/local concentrator.

The Anaconda facility which employs nearly 1,200 workers, receives concentrated ore (surry) directly from Butte. The Butte-Anaconda and Pacific railroad transports the ore by tankcar between the two cities. This ore is then processed and cast into annodes to be further refined at the Great Falls plant. The Great Falls plant, employing about 600 people, finishes the process, producing copper wire or ingots. The product enters the national market at this point being sold directly as a final product or as an intermediate product for further manufacturing.

The smelting facility in Anaconda is the dominant industry in Deer Lodge County. Nearly 20 percent of the employment in the area is provided by this single plant. The region has many of the characteristics of the Butte area, i.e., slow employment growth and relatively high unemployment and out-migration rates.

Cascade County, where Great Falls is located, has also experienced slow growth since 1970. Although unemployment in the county is currently below the 1977 state average significant out-migration has taken place since the 1970 census. Unemployment in the area significantly increased as a result of permanent lay-offs by Anaconda in the 1970-1973 period. However, since that time, the economy has stabilized, no doubt, related to its size. The Great Falls employment base is much larger than either the Anaconda or Butte area. Presently about 1.5% of the area's work force is employed at the plant, a much smaller percentage than in the mining district. The fourth Anaconda plant in Columbia Falls processes aluminum and is not affected by the Butte area.

Metal Mining Projections

Copper production has significantly varied since 1960. Even in view of the recent decline, there are no indications that output will decrease further. In fact, most long-term projections (OBERS, Chase, etc.) call for moderate increases in output over the next twenty years. This is also the case with the projections presented in this report. Production is expected to continue until 1995 when production is assumed to remain constant.

Output/employment ratios are also expected to increase, but not as rapidly as in the past. The projections are largely based on judgment. That is, the values are somewhat lower than the trend level since the gradual closing of underground operations will no longer play a role in the upward drift in productivity.

The production of gold has been fairly constant since 1960 and is projected to remain at about the 1975-1977 level throughout the projection period. On the other hand, zinc production is off sharply from the levels of the middle 1960's. As a result, no future increases are projected. Zinc production at the Great Falls smelting/refining facility ceased operation in 1971 resulting in the dramatic decline shown in Table 16. Only one plant now processes zinc, the ASARCO facility at East Helena.

The productivity levels for gold and zinc must be used with caution, since employment in the mining sector is totally dominated by copper. These ratios fluctuate wildly and little meaning can be attached to the variations. However, projected output/employment ratios for gold and zinc seem to be consistent with the historical ratios so that production and employment projections appear to be plausible.

TABLE 16

Montana Mineral Production

Year	Recoverable Copper (short tons)	Gold (troy ounces)	Recoverable Zinc (short tons)
1960	91,972	n/a	n/a
1961	104,000	35,377	10,262
1962	94,021	24,387	37,678
1963	79,762	18,520	32,941
1964	103,806	29,115	29,059
1965	115,489	22,722	33,786
1966	128,061	25,009	29,120
1967	65,483	9,786	3,341
1968	69,480	13,385	3,778
1969	103,314	24,189	6,143
1970	120,412	22,456	1,457
1971	88,581	15,613	361
1972	123,110	23,725	12
1973	132,446	27,806	73
1974	131,131	28,268	136
1975	87,959	17,259	110
1976	91,111	24,075	64
1977[P]	89,000	24,100	75
1985	105,000	22,000	100
1990	115,000	22,000	100
1995	120,000	22,000	100
2000	120,000	22,000	100

Data Source: U.S. Department of Interior, Bureau of Mines, Minerals Yearbook.

Projections: Western Analysis, 1978.

TABLE 17

Montana Productivity Ratios for Mineral Production

Year	Employment		Copper		Gold		Zinc	
	(000s)	Index	Index	Ratio	Index	Ratio	Index	Ratio
1960	4.5	140.6	140.5	99.9	-	-	-	-
1961	4.2	131.3	158.8	121.1	361.5	275.7	307.2	234.2
1962	3.8	118.8	143.6	120.9	249.2	208.0	1127.8	949.3
1963	4.1	128.1	121.8	100.0	189.2	155.3	986.0	809.5
1964	4.8	150.0	158.5	105.7	297.5	198.3	869.8	579.9
1965	4.6	143.8	176.4	122.7	232.2	161.5	1011.3	703.3
1966	4.8	150.0	195.6	130.4	255.6	170.4	871.6	581.1
1967	3.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1968	2.3	71.9	106.1	147.6	136.8	190.3	113.1	157.3
1969	3.3	103.1	157.8	153.1	247.2	239.8	183.9	178.4
1970	4.0	125.0	183.9	147.1	229.5	183.6	43.6	34.9
1971	2.9	90.6	135.3	149.3	159.5	176.1	10.8	11.9
1972	3.7	115.6	188.0	162.6	242.4	209.7	.3	.3
1973	3.8	118.8	202.3	170.3	284.1	239.1	2.2	.2
1974	4.0	125.0	200.3	160.2	288.9	231.1	4.1	3.3
1975	3.1	96.9	134.3	138.6	176.4	182.0	3.3	3.4
1976	2.4	75.0	139.1	185.5	246.0	328.0	2.2	2.5
1977	2.0	62.5	135.9	217.4	246.3	394.1	2.2	3.0
1985	2.0	62.5	160.3	230.0	224.8	239.0	3.0	3.2
1990	2.5	78.1	175.6	230.0	224.8	256.0	3.0	3.4
1995	2.5	78.1	183.3	230.0	224.8	276.0	3.0	3.6
2000	3.0	93.8	183.3	230.0	224.8	299.0	3.0	3.8

Data Sources: Minerals Yearbook, Bureau of Mines.
Employment Security, 790 Series.

Projections: Western Analysis, 1978.

Coal, Oil and Gas Projections

The coal production projections presented in this report show a large increase in mining activity to the year 1990 and then constant production to 2000. After 1990, environmental regulations will soften the demand for Western coal. While there are many'guesstimates' of future levels of coal production, the figures presented here represent about the average of the various independent projections.

The output/employment ratios for coal are expected to remain almost constant throughout the projection period. This assumption is quite plausible given the historical ratios.

Historically, natural gas production has fluctuated a great deal from year-to-year and there appears to be no true production trend, even considering current national shortages. The projections for gas output are therefore set at approximately the average of the last three years. Given the current price and reserve level for gas, these projections might tend to be conservative.

There are no data available for gas production employment. Therefore, a combined oil and gas production employment level was used to develop the productivity ratios. These projections are consistent with the employment projections presented earlier. The projected ratios are constant throughout the entire period and should be used with care given the inconsistencies in the employment patterns in this sector.

Oil production is projected to decline over the next twenty years. Most of the oil fields in Montana are fairly old and production-decline curves fitted to output data from each of these fields indicate no future increases. These projections would be totally upset by the discovery of another Belle Creek or a major find in the overthrust belt.

However, this sort of prediction is impossible, and a moderate decline is assumed.

Given constant employment over the period and declining output projections, the productivity ratios appear to be falling to levels inconsistent with the historical data. However, it should be noted that the employment data consists of both the oil and gas production categories so that any credence given to the output/employment ratios should be carefully scrutinized.

Current Issues

Like the wood products industry, most of the debate in the mining sector focuses on environmental trade-off and economic growth. Again, polar extreme views dominate much of the argument.

Ten years ago, energy was cheap, minerals seemed abundant and the American life-style was more extravagant than ever. With only six percent of the world's population, the U.S. was using a third of its energy. We were burning fossil fuels and extracting minerals as if the supply were infinite. Ironically, this pattern has not changed even with the 1973 Arab embargo. Industry has effected some very significant energy savings, but gasoline, oil, and heating fuel consumption has continued to edge up, despite such savings.

While the so-called "soft" alternatives are looking better and better, nuclear and coal have run into some big problems. Fission, once touted as the wave of the future, has become ensnarled in safety and economic questions. Fusion may be more feasible in the long run, but it will require massive funding for years of research. Coal could dirty up the air and strip mining inflicts costly surface damage. Beyond that, there are serious reservations about coal's long-term

TABLE 18

Montana Output of Coal and Petroleum Products

	Coal* (million tons)	Natural Gas (Million cubic feet)	Crude Petroleum (1000.42 gallon barrels)
1960	n/a	n/a	n/a
1961	n/a	33,701	30,906
1962	n/a	29,955	31,648
1963	n/a	30,026	30,870
1964	n/a	25,188	30,647
1965	n/a	28,105	32,778
1966	n/a	30,685	35,380
1967	n/a	25,866	34,959
1968	n/a	19,313	48,460
1969	n/a	41,229	43,954
1970	n/a	42,705	37,879
1971	7.1	32,720	34,599
1972	8.0	33,474	33,904
1973	110.4	56,175	34,620
1974	13.6	54,873	34,554
1975	22.1	40,734	32,844
1976	26.2	42,563	32,814
1977	27.7	48,663	32,914
1985	56.0	45,000	31,000
1990	63.0	45,000	30,000
1995	63.0	45,000	29,000
2000	63.0	45,000	28,000

Source: Coal; Research Division, Montana Department of Revenue.
Oil and gas; U.S. Department of Interior, Bureau of Mines, Minerals Yearbook.
Projections: Western Analysis, 1978.
Note: Various other projections are available from Old West, DNR, the University of Montana, MEAC (no longer in existence), Northern Powder River Basin Group, and the Northern Great Plains Commission.

TABLE 19

Montana Output and Employment Indices
Coal and Petroleum

	Employment		Production		
	Coal (1971=100)	Gas and Oil (1967=100)	Coal	Gas	Oil
1960	n/a	n/a	n/a	n/a	n/a
1961	n/a	129.4	n/a	130.3	88.4
1962	n/a	129.4	n/a	115.8	90.5
1963	n/a	123.5	n/a	116.1	88.3
1964	n/a	111.8	n/a	97.4	87.6
1965	n/a	105.9	n/a	108.7	93.8
1966	n/a	100.0	n/a	118.6	101.2
1967	n/a	100.0	n/a	100.0	100.0
1968	n/a	129.4	n/a	74.7	138.6
1969	n/a	135.3	n/a	159.4	125.7
1970	n/a	105.9	n/a	165.1	108.4
1971	(196) 100.0	94.1	100.0	126.5	99.0
1972	(300) 153.1	94.1	112.7	129.4	97.0
1973	(330) 168.4	94.1	146.5	217.2	99.0
1974	(445) 227.0	105.9	191.5	212.1	98.8
1975	(745) 380.1	105.9	311.3	157.5	94.0
1976	(860) 438.8	117.6	369.0	164.6	93.9
1977	(900) 459.2	147.1	390.1	188.1	94.1
1985	867.3	147.1	788.7	174.0	88.7
1990	969.4	147.4	887.3	174.0	85.8
1995	969.4	147.1	887.3	174.0	83.0
2000	969.4	147.1	887.3	174.0	80.1

Source: Employment and output indices based on data from this report.

Projections: Western Analysis, 1978.

TABLE 20

Montana Output / Employment Ratios
Coal and Petroleum

	Coal	Gas	Oil
1960	n/a	n/a	n/a
1961	n/a	100.7	68.3
1962	n/a	89.5	69.9
1963	n/a	94.0	71.5
1964	n/a	87.1	78.4
1965	n/a	102.6	88.6
1966	n/a	118.6	101.2
1967	n/a	100.0	100.0
1968	n/a	57.7	107.1
1969	n/a	117.8	92.9
1970	n/a	155.9	102.4
1971	100.0	134.4	105.2
1972	73.6	137.5	103.1
1973	87.0	230.8	105.2
1974	84.4	200.3	93.3
1975	81.9	148.7	88.8
1976	84.1	140.0	79.9
1977	85.0	127.9	64.0
1985	90.9	118.3	60.3
1990	91.5	118.3	58.3
1995	91.5	118.3	56.4
2000	91.5	118.3	54.5

Projections: Western Analysis, 1978.

effects of the climate.

Alternatives are being developed for other minerals as well as for fossil fuels. At the University of Pennsylvania, researchers are working on a "supermetal" made out of ordinary carbon that could replace copper as an electrical conductor. But although the new science of molecular engineering may turn up some valuable substitutes, the most promising idea for conserving raw materials is an old one. It's called recycling.

Right now, about two-thirds of all the things we use could be recycled. Americans throw away 70 percent of all metal after it is used just once. Only a fraction as much energy is required to recycle metal as to mine and refine raw ore. And the pollution problems created by the conventional open dump have become unmanageable. The only answer, therefore, is to discard our throwaway mentality and put a new emphasis on waste recovery and material reuse.

Important issues affecting various mining activities will now be discussed.

Coal

Coal was to the industrial revolution what yeast is to bread - the essential starter. With it society set about creating the tools, processes and institutions that shape contemporary life. In a comparative sense, the United States came into the coal age late, withdrew early, and has now returned. Coal did not become the most popular fuel until after the Civil War, but by the turn of the century contributed over 70 percent of national energy use. Today the share is growing, but still accounts for less than 20 percent of the total. The early decline was almost entirely the result of rapid technological change,

i.e., the internal combustion engine, electrical generation and transmission, pipelines, and the relative ease in home heating of other energy types.[38]

From the early 1940's until just recently coal was treated like the mineral equivalent of a nettle. However, shortages in oil and gas have changed this view. When the Carter Administration took office in 1977 one of the major priorities was to do something about the energy crisis. The bottom line of this plan which emerged in April 1977, was to reduce foreign oil consumption by approximately one-third or face dire economic and political consequences. Of more interest to Montana was the President's substitute for oil . . . "We should double the amount of coal we are presently consuming."

The plan immediately drew heavy criticism from the GAO, the industry, and environmental organizations as being wildly optimistic. A discussion of several major issues follows.

To produce 1.2 billion tons of coal by 1985 and maintain these production levels at least until 2000, there would be a need to open between 400 and 800 new mines. This would have to begin immediately since, the GAO reports, technological proparations and legal requirements, especially environmental ones, make opening mines time-consuming. Currently, it takes between two and one-half and five years from initial planning to start-up for a new eastern underground mine. A minimum of four years and a maximum of 15 years are required to open a western strip-mine.

In comparison to other fuels, coal production is especially labor

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[38] The Second Reign of Old King Coal, National Audubon, 1978.

intensive. In 1973, 160,000 miners produced coal worth 14 BTU quads of heat. About 275,000 oil and gas workers produced 43 BTU quads. To get even a billion tons of coal by 1985 the GAO estimates we will have to hire and train 157,000 more miners and support employees. Included are 3,000 mining engineers, almost double the number now employed in the coal industry.

In 1940, American coal miners each produced five tons of coal a day. In the next quarter-century this average rate of production sharply increased because of new underground techniques and equipment and especially because of the development of strip-mining. Productivity peaked in 1969 when average production was 20 tons per miner per day - 14 tons a day for underground miners and 36 tons a day for strip-miners. Since then productivity has declined drastically because of the growing obsolescence of equipment, labor unrest, and new health and safety regulations that prohibit old, high-yield mining practices, now judged to be too unhealthy or dangerous. In 1976 average daily production of all miners was only 13.5 tons. However, Montana coal productivity is six times higher and still rising, a difference almost entirely related to more efficient strip-mining techniques.

Other serious constraints to an expansion of this magnitude include tremendous capital outlays in mining, transportation, and generation facilities and potential alteration of environmental quality. Also, the first GAO report commented, "The major impact of the plan as proposed seems to be reducing oil imports by shifting to coal rather than by conserving energy."

The impact on Montana is very difficult to assess. The demand for low-sulfur coal, of which Montana has an abundance, has been the

primary determinant of growth. In all probability this demand will become even greater. But, there are several factors which may constrain development. Most importantly, if the United States Environmental Protection Agency (EPA) further tightens its emission standards so as to require scrubbers, the demand could shift to eastern coal.

The simulated change in regional flow patterns between base case and 90% emissions removal is shown in Diagram 5. It should be noted, however, that the actual impact of such a proposed change is extremely difficult to quantify. It is also difficult to guess what efficiency standards will be required of the industry. In light of this uncertainty, it is not surprising that different researchers have produced quite different results. Three recent studies, however, suggest that the impact on coal production in the Northern Great Plains area could be as much as 35 percent less than the base case.[39, 40, 41] Other earlier studies have come so far as to suggest that the demand for Montana coal with "best technology" would disappear.

The general effects of changing control technology are outlined below:

- The major impacts of raising the emission floor are 1) increased emissions, 2) increased shipments of Western coal to the East, 3) lower utility oil consumption and 4) lower annualized costs.

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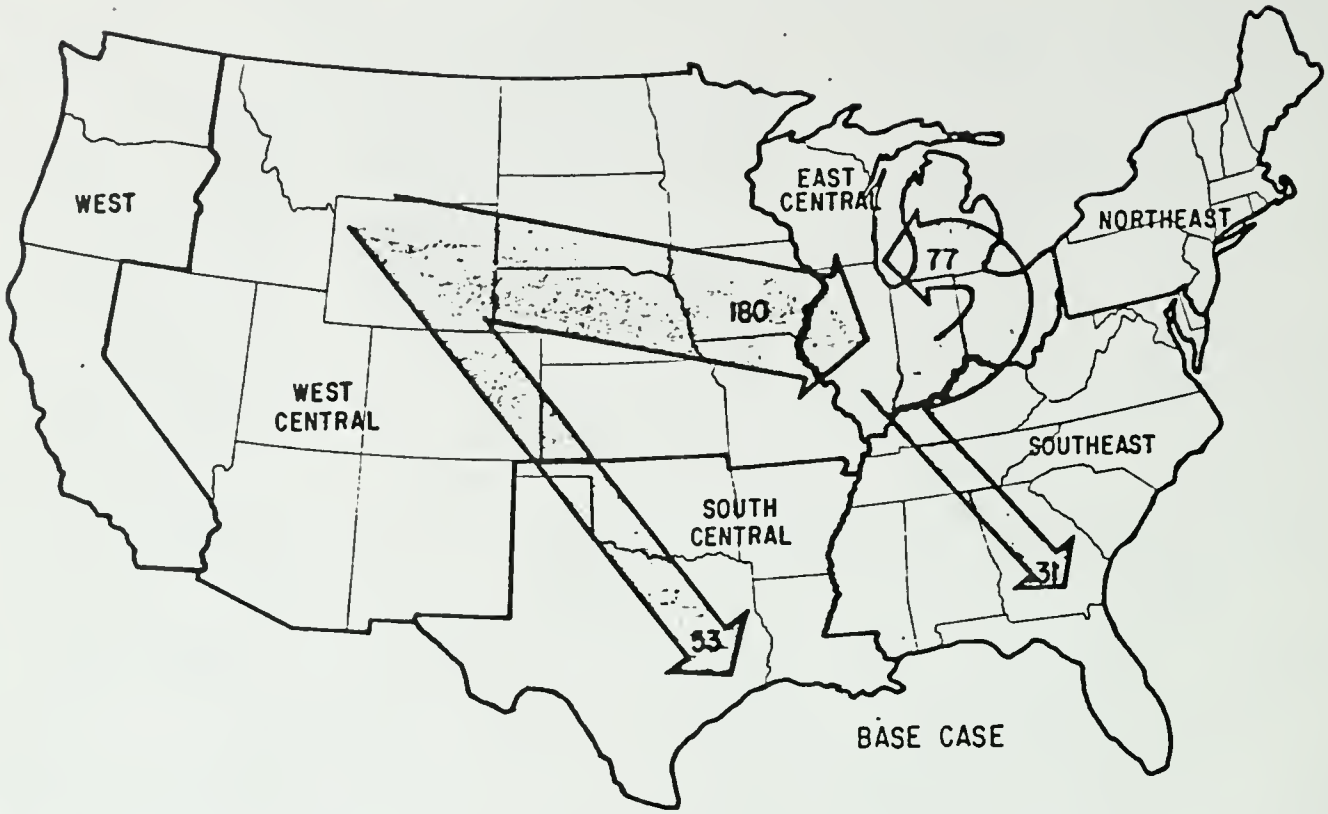
[39] T. Wheeling, Electric Utility Coal Demand Scenarios, MERDI, 1978.

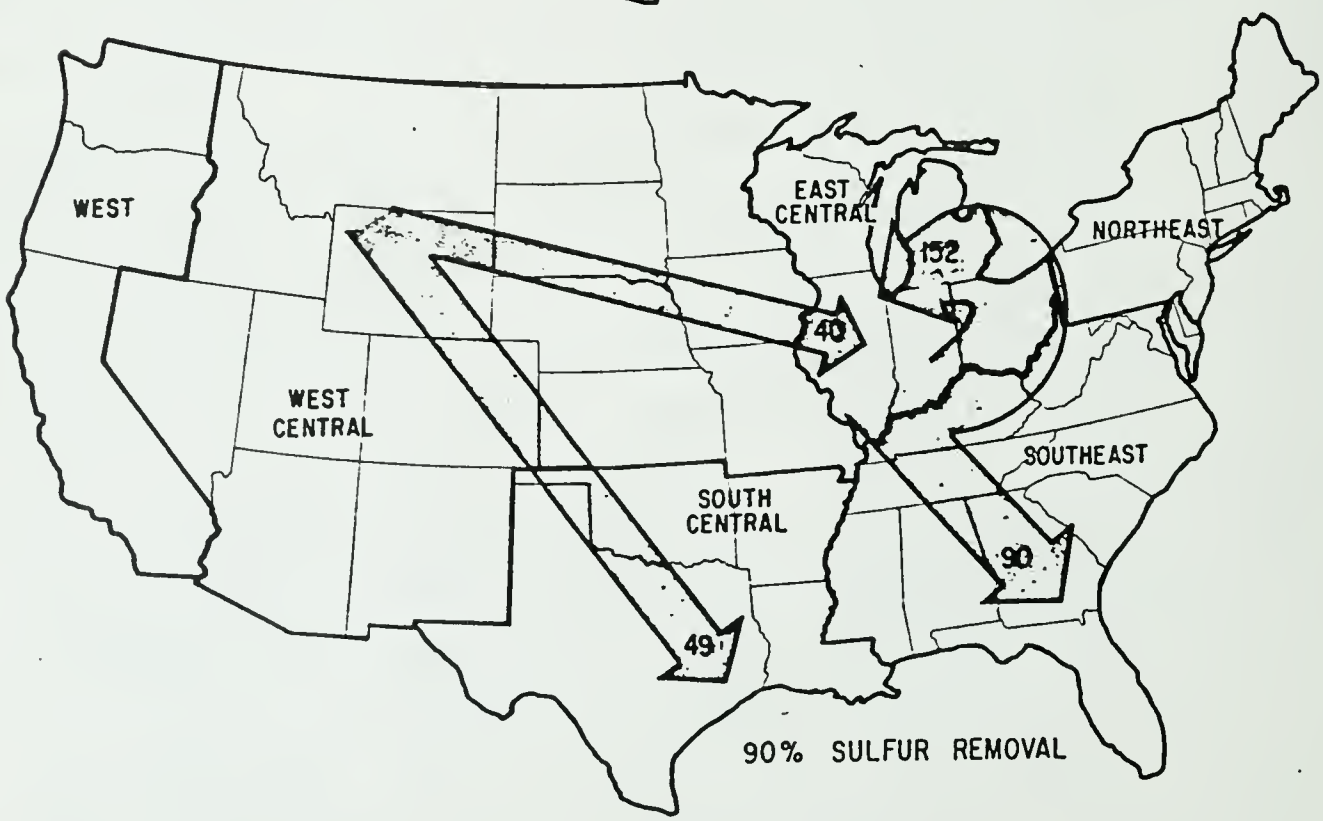
[40] Environmental Protection Agency, Effects of Alternative New Source Performance Standards, 1978.

[41] Argonne National Laboratory, Effects of Regional Coal Markets of Best Available Control Technology, 1978.

DIAGRAM 5

Interregional Flow of Coal





Major Changes in Interregional Flows Resulting from BACT in 1990 (10^6 tons/year)

Source: Argonne National Laboratory, National Coal Utilization Assessment, 1977.

- The major impacts of lowering the ceiling are 1) increased Western coal shipments to the East, with a significant decline in Midwestern coal production, 2) higher annualized costs, and 3) sometimes a decrease in SO_2 emmissions.

- The major impact areas for the exemption from the ceiling are the same as for changing the ceiling, since such an exemption has the effect of raising the average sulfur content of coal that can be utilized with any given ceiling. An exemption from the ceiling would reduce the amount of Western coal shipped to the East, lead to more Midwestern production, reduce the annualized utility costs by increasing the amount of coal reserves that the ANSPS plants can burn, and increase SO_2 emissions.

Other important policy considerations affecting Montana coal production include federal coal leasing, the Montana Major Facility Siting Act, coal slurry pipelines, the Montana coal severance tax, relative transportation costs and bottlenecks, current over-production at several mines, environmental impact statement delays, the 1977 Strip Mine Act and a host of other factors. In other words, technological change is in all probability no where near as important as governmental regulations.

Coal Mining and Technology

Most of the developments in this industry show horizons being pushed back, more as a function of the economics of energy than technology. As long as natural gas and oil are held below world and free market prices, the government subsidy of the consumer will thwart commercialization of existing technology - coal gasification, solar, etc.

However, developments seem to be just over the hill despite the economic drawbacks. Hydraulic underground coal transportation systems should be developed, economically feasible and in widespread

use within the next decade. Another respondent noted "Within the next decade the longwalling method of underground mining will begin to dominate the scene in the U.S. . . . American manufacturers are just beginning to produce machinery designed especially for U.S. conditions underground." Automation of underground mining and transportation is a slowly evolving technology with the median year of breakthrough being 1985, economic feasibility the year after and widespread use by 2000.

Plants producing pipeline gas and synthetic crude from coal will be technologically feasible in 1982 but won't be widespread because of the economic edge still held by petroleum until 2000. A new, commercially successful method of removing sulfur from coal won't be technologically proven until 1980 and economically feasible until 1985 with widespread use ten years later.[42]

The McGraw Hill survey of several hundred R & D facilities, universities and businesses indicates that significant technological advances may be realized in the next 20 years. Some of these potential changes may stimulate Montana coal output, but most are geared toward traditional underground mining applications. Given Montana remoteness from markets, the future of instate coal expansion may be "relatively" curtailed by such developments. Several such innovations are currently being tested in underground mines in West Virginia.[43]

Coal gasification and other forms of synthetic fuel development appear to be at a standstill. But rising foreign oil prices may

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[42] McGraw Hill, Technological Survey, 1978.

[43] Coal Mining and Processing, Haulage Technology Increase Low-Seam Output by 50%, 1978.

TABLE 21

Technological Breakthroughs & Widespread Applications
by Industry or Field
(Median Year)

	Year of Breakthrough		Year When Economically Feasible		Year When in Widespread Use	
	1978 Study	1975 Study	1978 Study	1975 Study	1978 Study	1975 Study
COAL MINING						
1. Hydraulic underground coal transportation system	1979	1980	1982	1982	1988	1990
2. Plants producing pipeline gas and synthetic crude from coal	1982	1980	1985	1986	2000	1989
3. Method of removing sulfur from coal before it is burned	1980	1976	1985	1979	1995	1985
4. Automation of underground mining and transportation	1985	1980	1986	1984	2000	1995
5. Commercial recovery of methane from coal seams	1980	*	1986	*	1990	*
6. Commercial gasification of coal seams in place	1985	*	1988	*	1995	*
7. Commercial liquefaction of coal seams in place	1990	*	1995	*	2000	*
8. MHD Generators	1990	1980	2005	1995	2025	2000

* Not asked in 1975

Source: McGraw Hill, 1978.

accelerate research interest in alternative energy forms - including synthetic fuels. But, in addition to price constraints, synfuels have other problems, many of them environmental.

Strip-mining to get at shale and tar sand is not looked on favorably by environmentalists, and the manufacturing processes for those fuels and coal gasification can cause pollution.

But backers of synfuels think their problems are surmountable. And at the right price, synfuels could play a significant part in the nation's energy picture.

Natural Gas

Declining domestic reserves, curtailment of Canadian gas imports, and rapidly rising prices have resulted in stepped up exploration in Montana. The major suppliers of gas include the Montana Power Company (65 percent of sales), Montana-Dakota Utilities (25 percent), and nine small utilities comprising the remainder of sales. Although instate production of gas has increased approximately 30 percent since 1960, net imports still represent about 35 percent of total consumption. The level of imports, however, has sharply declined within the last few years. For example, in 1973, 87 percent of Montana Power's sales were made from imported gas. Since Canada announced that export licenses would not be renewed, MPC substantially increased expenditures for instate exploration. As a result, Montana production going to MPC approximately doubled and statewide imports for all utilities were reduced by more than 50 percent.[44]

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[44] J. Duffield, Montana Natural Resource Assessment: Energy Minerals, University of Montana, 1978.

Canadian export reductions have been more than offset by increased Montana production and reduced consumption. MPC is, in fact, currently in a supply surplus situation. To a degree, this reversal may be related to very rapidly increasing prices resulting in conservation. Furthermore, a recent study suggests that Montana appears to be assured of a good gas supply through the end of the century.[45] But, no gasification plants are assumed to be feasible within the next 20 years.

Current Issues

Conservation of gas as prices continue to rise will help to prevent future shortages. National gas deregulation should also help to motivate exploration and dampen demand. However, the industry claims that RARE II and related federal wilderness policies and leasing problems may represent a significant barrier to development, particularly in the Rocky Mountain front, also known as the overthrust belt.

Gas Technology

If it were possible to predict oil and gas finds, clearly no one would say a word. But rather they would begin to buy up all available leases. This may be happening at least to a degree, no doubt related to the current international picture and the "high" geological potential for discovery in certain areas of Montana. Whatever the reason, lease prices have "gone out of sight" within the last few years.

Unconventional gas sources once considered too difficult or too costly to exploit are rapidly becoming practical. These new sources include:

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45 W. Brinker, Oil and Gas Supply in Montana, 1970 to 2000, MERDI, 1978.

- Geopressure zones. Interest is focused on the Gulf Coast region, but researchers have identified several other U.S. regions that also may contain significant resources.

- Deep basins. Today drillers are finding unheralded quantities of gas at depths between 15,000 and 30,000 feet.

- Western "tight sands." In the Rockies drillers have learned how to extract gas from concrete-hard sandstones estimated to contain some 800 trillion cubic feet (TCF).

- Coal seams. An estimated 850 TCF of gas exists in the nation's coal seams at depths as great as 6,000 feet.

- Devonian shales. More than 1,000 TCF is believed trapped in dense rock underlying 90,000 square miles of Appalachia.

- Methane hydrates. At certain pressures and temperatures, methane and water form an icelike substance beneath permafrost and in deep-ocean bottoms. Undetected in nature until the mid 1960's, hydrates may have captured enormous quantities of gas thought to have dissipated millennia ago.

"If we recover only a small percentage of all this gas, we'd more than quadruple our present estimates of potential resources," says one government researcher. "But this is scarcely mentioned as a possibility in our energy plans."[46]

In the West, hydraulic fracturing techniques may become widespread. This form of drilling is now feasible whereas a few years ago it was not. The process involves forcing fluids at high pressure down wells to create underground cracks as much as a mile long in the tight-sand beds. Sand grains carried by the fluid lodge in the cracks, propping them open, allowing from five to twenty times more gas to reach the well than with conventional techniques.

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[46] National Geographic, Natural Gas: The Search Goes On, 1978.

Coal seam-methane generation may also become feasible. Several firms are currently researching this potential in Utah where several test boreholes have been drilled with good results. Coal-seam methane is nothing new. Miners have feared and fought it for years, and thousands have died in methane-triggered explosions. In 1964 the U.S. Bureau of Mines began a research program designed to remove the deadly hazard and cut ventilation costs by drilling into coal seams before they were mined.

Other potential technological breakthroughs include extraction of gas from shale - mostly in Appalachia - deeper and deeper drilling and even barnyard gas. Of course, the price has to be right first.

Petroleum

As a nation we have developed a seemingly incurable petroleum habit, one which will be very difficult to kick. Over half of the ever growing national demand is supplied through imports presenting the potential for a dangerous series of economic and political consequences. And, it is nearly unbelievable that five years after the oil embargo, there is still no energy plan.

Unlike coal, Montana's petroleum is in short supply - most fields are relatively old and declining. Unless new areas are successfully explored and new technologies adopted, it is likely that output will gradually decline.

Montana crude production has been relatively stable for the last few years - averaging about 34,000,000 barrels annually. However, at the current extraction rate, assuming no discoveries, known reserves could be depleted within 10 years. Although current reserve estimates vary widely, data supplied by the American Petroleum Institute indicate

that total proven reserves have declined by nearly 50 percent within the last ten years.

The most important potential impact of the petroleum sector in Montana is in the refining industry concentrated in Yellowstone county. These firms - Cenex, Exxon, and Continental have a major impact on the Billings economy employing approximately 1100 workers, mostly high paid jobs. Since the late 1960's, these refineries have depended on imported Canadian crude which will no longer be supplied after 1982. As recently as 1976, nearly one-half of all oil refined in Montana was from Canada.

Another factor which complicates the problem is that the technology of the refineries is geared toward low sulfur, "sweet", Canadian feed stock and not easily adaptable to crude from Wyoming. Wyoming crude would also result in increased residuals, such as asphalt which is difficult to market because of it's bulk and relatively low value. A temporary solution may be to exchange crude sent to eastern Canadian refineries for imports. In the long-term the solution is to replace the Canadian feedstock with imported crude via the proposed Northern Tier Pipeline.

Current Issues

The primary factors which will influence crude petroleum extraction include conservation, federal crude oil pricing, federal and state leasing, environmental policies, and taxes. Many of these issues are nearly identical to those discussed in the gas section. In the short run the most flamboyant debates will probably continue to center on RARE II and Northern Tier.

Although the prospects of significantly increasing the levels of oil and gas production are not high, the outlook for increased

employment is favorable. Drillers in the Montana portion of the Williston Basin are having extraordinary success in deeper exploratory and development drilling. The potential of the overthrust belt, a portion of the Rocky Mountains which ranges through western Montana, has caused accelerated bidding at state land sales. Utah, Wyoming, and Canada have experienced success in oil and gas discovery in the overthrust belt, hence the strong interest in the area by Montana developers.

The experimental tertiary recovery of crude oil in the Belle Creek Field in Powder River County has also been highly successful. By employing a process called mycellar-polymer flooding, the Bell Creek Field produced over 9 million barrels of crude oil in 1977 - the highest production of any field that year. The new strikes and improved technology may maintain current production levels of oil and gas for a few more years.

Enhanced Oil Recovery Potential (EOR)

Proved oil reserves are defined as oil that can be produced with current technology under specified economic conditions (usually current costs and prices). Consequently, estimates of potential additions to proved reserves resulting from the application of new techniques vary with the price of the oil. The results of OTA's analysis are summarized in Table 22.

The initial stage in producing oil from a reservoir is called primary production. During this stage oil is forced to the surface by such natural forces as: a) expansion of oil, expansion of the contained gas, or both; b) displacement by naturally pressurized water, and c) drainage downward from a high elevation in a reservoir to wells penetrating lower elevations.

TABLE 22

Estimates of Ultimate Recoverable Oil and
Daily Production Rates From EOR:
Advancing Technology Case With
10 Percent Minimum Acceptable Rate of Return

	Price per barrel	Ultimate recovery [c] (billions of barrels)	Production rates (millions of barrels/day) 1985	1990	2000
High-process performance					
Upper tier:	$11.62	21.2	0.4	1.1	2.9
World oil:	$13.75 [a]	29.4	1.0	1.7	5.2
Alternate fuels:	$22.00 [b]	41.6	1.3	2.8	8.2
	$30.00	49.2	- [d]	-	-
More than	$30.00	51.1	-	-	-
Low-process performance					
Upper tier:	$11.62	8.0	0.4	0.5	1.1
World oil:	$13.75	11.1	0.5	0.7	1.7
Alternate fuels:	$22.00	25.3	0.9	1.8	5.1

[a] $13.75 is the January 1977 average price ($14.32 per barrel) of foreign oil delivered to the east coast, deflated to July 1, 1976.

[b] $22.00 per barrel is the price at which the Synfuels Interagency Task Force estimated that petroleum liquids could become available from coal.

[c] These figures include 2.7 billion barrels from enhanced recovery processes that are included in the API estimates of proved and indicated reserves.

[d] Production rates were not calculated for oil at prices of $30 per barrel or higher.

Source: Office of Technology Assessment, Enhanced Oil Recovery Potential in the United States, 1978.

The natural expulsive forces present in a given reservoir depend on rock and fluid properties, geologic structure, and to some degree on the rate of oil and gas production. Recovery efficiencies in the primary stage vary from less than 10 percent to slightly more than 50 percent of the oil in place.

Most of a reservoir's oil remains in place after the natural energy pressurizing the reservoir has been dissipated. Several techniques for injecting fluids into an oil reservoir to augment the natural forces have been widely used for many years. Such fluid injection is generally known as secondary recovery.

Processes that inject fluids other than natural gas and water to augment a reservoir's ability to produce oil have been designated "improved", "tertiary", and "enhanced" oil recovery processes. The term used in this assessment is enhanced oil recovery (EOR).

According to American Petroleum Institute estimates of original oil in place and ultimate recovery, approximately two-thirds of the oil discovered will remain in an average reservoir after primary and secondary production. This inefficiency of oil recovery processes has long been known and the knowledge has stimulated laboratory and field testing of new processes.

Steam injection is the most advanced and most widely used EOR process. It has been successfully used in some reservoirs in California since the mid 1960's. There are two versions of the process: cyclic steam injection and steam drive. In the first, high-pressure steam or steam and hot water is injected into a well for a period of days or weeks. The injection is stopped and the reservoir is allowed to "soak." After a few days or weeks, the well is allowed to backflow to the surface.

The second method, steam drive or steam flooding, involves continuous injection of steam or steam and hot water.

Other types of injections include CO_2. Although there are many possible CO_2 sources, the largest source is found in naturally occurring deposits. The use of certain types of chemicals (polymers and alkalines) also has high potential for enhanced recovery. Another example involves use of electrical energy to fracture an oil-bearing formation and form a carbon track or band between wells. This band would then be used as a high-resistance electrical pathway through which electric current would be applied, causing the "resistor" to heat the formation, reduce oil viscosity, and increase oil recovery. The use of bacteria has also been considered to generate detergent-like materials similar to chemical injection. However, neither the electrical or biological recovery methods are likely to be feasible.[47]

Copper

Copper is far and away the most important non-fuel mineral produced in Montana, and its occurrence with other metals (gold and silver) contributes to its significance. Almost all of the copper is currently produced within the Butte area but a new facility (ASARCO) of much smaller scale is scheduled to begin production in the early 1980's. This particular mine, near Troy, would employ underground techniques whereas mining in the Butte district is entirely open pit.

Although present operations are extremely concentrated, other important reserves exist outside of the Butte district. The Montana Bureau of Mines and Geology has identified other important areas in

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[47] Office of Technology Assessment, Enhanced Oil Recovery Potential in the United States, 1978.

Lincoln County, (the ASARCO mine proposal) and within the Stillwater Complex, an area rich in other minerals as well. There appears to be no shortage of copper, in part, reflected by low market prices on an international level.

Depressed prices and intense international competition were responsible for the closure of underground operations in Butte (1975). The domestic industry regards certain types of competition as unfair, at least to the degree that other countries (Peru, Chile, and South Africa) are not operating under the same constraints. Specific debate over import policy centers on environmental costs associated with production in the U.S. and "dumping" at a price subsidized by foreign governments. However, within the last few months copper prices have increased to some extent.

Even though output levels are significantly lower (about 30 percent) during the early 1970's most national projections indicate increasing production for the next 10-15 years. The long-term declines in copper employment may, in fact, even reverse. But, the short-term outlook is not encouraging in view of surplus stocks and excess capacity.

Within the last few years Anaconda Company geologists have become aware of a copper-silver-molybdenite deposit within the central Butte district. The cupola-like part of this ore body is about 3,000 feet below surface; therefore, a block-caving method to mine this deposit is being contemplated. This deposit is estimated to contain several hundred million tons of ore higher in grade than present Berkeley pit ore, but it will not be mined until those ore reserves are exhausted (about 12 years). The development and production of this deposit will

increase employment for Silver Bow County.

One factor mentioned earlier which could significantly alter the market within the next five to ten years could be the development of high grade, low cost, conductors - carbon derivative wiring maybe especially important. Such a breakthrough could conceivably alter the demand for copper since over half of copper production today is used for electrical purposes. Other technological advances in non-fuel minerals are considered in the following section.

Other Non-fuel Minerals

Montana is well endowed with other minerals in addition to those already mined. Some of the commodities have no present market because of price or uniqueness but others may be of great importance. According to state geologist Dr. Sid Groff, the potential for chromium-copper-iron development is very high within the Stillwater Complex. Montana has approximately 70 percent of national chromium reserves. And even though this ore is relatively low grade, it may become of particular importance since the U.S. is heavily dependent on foreign supplies. Given its importance in metallurgical, chemical, and refractory industries, it is one of the nation's most important materials. Refining of this ore (Stillwater) would, however, require technological advances and significant increases in electrical power availability.

Exploration for talc deposits is active in Madison and Beaverhead counties, and it is believed that additional deposits will be discovered in these areas. The Pony vermiculite deposit is being purchased by a major company, and ore reserves may be sufficient to encourage development and production.

Silver, nickel, and molybdenum reserves and resources have been

explored in a number of Montana counties, namely Lincoln, Lewis and Clark, Flathead, Carbon, Silver Bow, Mineral, and Cascade. Large manganese resources are present in both Silver Bow and Granite counties. Gold resources and reserves are being explored in Jefferson, Park, and Phillips counties. Gold, tungsten, and arsenic resources are present in southern Park County and in the East Pioneer and Flint Creek ranges of Beaverhead, Deer Lodge, and Granite counties. Iron and platinum resources are of significance in the Stillwater Complex (Stillwater, Sweet Grass, and Carbon counties); the Butte area in Silver Bow County has large reserves of zinc and some lead. Considerable reserves of titaniferous iron occur in a belt parallel to the Rocky Mountain Front (Teton, Pondera, and Glacier counties). Thorium resources in western Beaverhead County may prove to be of future economic significance. Vanadium and uranium are present in recoverable quantities in the Permian phosphate beds of western Montana and may be recovered as a by-product in future phosphate mining and processing.[48]

Bentonite development near Malta also holds strong promise. Bentonite is used in the production of paint, cake mixes, candy and tires. When wet it expands up to 1,500 percent. Oil-well drillers use it to lubricate their drill bits. In iron smelters it is used to tie tiny particles of iron ore together into pellets.

Mining and Metal Technology

One of the technological processes that looked so useful nearly 10 years ago has lost its promise. Fracturing various metal ore bodies by nuclear explosion is now not expected to be practical until 2000,

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[48] W. Johns, Economic Report to the Governor, Montana Bureau of Mines and Geology, 1978.

if ever.

New mining techniques such as the use of lasers and ultrasonics, etc. and hydraulic fracturing of ore bodies are expected to be technologically feasible by 1985 and 1990, respectively. Continuous underground mining machinery for "hardrock" ores is now being developed and should be practical by 1985 and in widespread use by 2000. Automation of underground mining machinery is expected by 1985 and to be economically feasible by 2000. In place retorting of oil shale is expected to be possible by 1982 and economically feasible by 1987. Significantly deeper exploration for new ore deposits is not expected until nearly 2000 when current supplies become scarce enough to justify the costs entailed in such operations.[49] Examples of new developments are shown in the following table.

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[49] McGraw Hill, Technological Survey, 1978.

TABLE 23

Technological Breakthroughs & Widespread Applications
by Industry or Field
(Median Year)

	Year of Breakthrough		Year When Economically Feasible		Year When in Widespread Use	
	1978 Study	1975 Study	1978 Study	1975 Study	1978 Study	1975 Study
METALS AND MINING						
1. Use of lasers, ultrasonics and high frequency currents for drilling, crushing and grinding rock	1985	1985	1992	1992	2005	2000
2. Widespread extraction of metals and minerals from ore in place by fracturing ore body with nuclear bombs and then leaching the metals with acid or other solutions	2000	1990	2015	2000	2038	2050
3. Extractions of metals and minerals from ore in place by fracturing ore body hydraulically	1990	1980	1994	1990	2005	2000
4. Recovery of minerals from seabeds	1982	1980	1988	1985	2000	2000
5. New alloys stronger, lighter, more corrosion resistant	1980	1976	1987	1980	1995	1990
6. Automation of underground mining	1985	1982	2000	1985	2022	1995
7. Extension of exploration for new ore deposits to great depths	1996	1990	2004	1990	2032	2000
8. Continuous steelmaking	1990	1985	1995	1990	2000	2000
9. Significant additions to present large-scale metal scrap recycling+	1988	1976	1990	1979	1994	1982
10. Production of primary aluminum by an inexpensive continuous process	1990	1985	1998	1990	2008	2000
11. Production of primary magnesium by a new, less expensive process	1986	1990	1993	1988	2008	1995
12. Inexpensive extractions of metals from seawater	2000	1985	2018	1990	2032	1995
13. In place retorting of oil shale	1982	1982	1987	1990	2002	2000
14. Recovery of low grade non-magnetic, taconite iron ore	1990	1980	1999	1990	2025	2000
15. Continuous underground mining machinery for "hardrock" ores, e.g., copper, iron, etc.	1985	*	1990	*	2000	*

\+ 1975 item: Large-scale metal scrap recycling
* Not asked in 1975

Source: McGraw Hill, 1978.

TRANSPORTATION

Beginning in the 1880's, the railroads brought people and economic activity to the state, and provided outlets for mineral and farm products. New towns were established at railheads and/or service points - Glasgow, Havre and Kalispell on the Great Northern; Glendive, Laurel, and Livingston on the Northern Pacific; Harlowtown on the Milwaukee; and Dillon on the Utah and Northern. Rail employment is still important to several of these cities - particularly Havre, Livingston, and Laurel.

Following the construction of the Milwaukee Road in 1909, there were 20,000 railroad employees in Montana compared to the present level of about 6,000. The depression resulted in a loss of nearly 10,000 rail workers, but World War II created an unusual demand for rail employment increasing the total level to nearly the number employed prior to the depression. However, after the war, rail employment dropped sharply. Passenger travel declined, trucks and planes captured a larger share of the freight business, and companies rapidly shifted from steam to diesel engines. Switchyards were automated, and several mergers also took place. Employment continued to fall as productivity per man increased.[50] The relative shift in emphasis between rail and motor carriers is shown in the following table.

Of course, the postwar decline was not unique to Montana. Decline at the national level followed a similar pattern, but railroads in Montana employed (and still employ) a larger proportion of the labor force, making the loss more significant here. Also rail jobs pay

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50 Bureau of Business and Economic Research, Montana Economic Study, University of Montana, 1970.

TABLE 24

Transportation Employment

	Rail	Other
1950	14,000	3,300
1960	9,000	4,000
1965	7,500	4,000
1970	6,600	4,600
1975	6,100	5,600
1976	6,100	5,700
1977	6,300	6,100

Source: Montana Department of Labor and Industry.

considerably more than the average for other sectors in the state's economy.

Current Issues

The decline in rail employment and rail service evidently has not stopped. Possible reductions of both passenger and freight rail service - Amtrack and the Milwaukee Road - are issues of great significance to the state. Transportation is basic to all economic development and of primary importance to agriculture. The same is true for the effects of airline deregulation. There are relatively fewer alternatives open to Montanans than in the more populated areas of the nation and greater distances to travel or transport products. Transportation access represents the single most important determinant of new plant siting.[51] Furthermore, as a result of the relative remoteness of the state, the overall cost of serving the national market is already approximately

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51 U.S. Department of Commerce, Economic Development Administration, Industry-Community Computer Matching Program, 1975.

50 percent above the national norm.[52] Additional reductions in rail service could have a significant impact, particularly at the community level. Good examples include Harlowtown, Deer Lodge and Glendive, all of which could be adversely impacted by closure of the Milwaukee.

National Railroad Issues

Until such time as innovation and reform stimulate the growth of rail traffic, the fortunes of the industry should ride on a fairly stable volume of traffic. If that is the case, then the key to higher wages, stable prices and increased profitability will be productivity - the efficiency with which labor and capital are employed to serve existing traffic.

Recent changes in the patterns of U.S. economic activity have been almost uniformly unfavorable to conventional rail service: the sluggish growth in consumption of bulk commodities, particularly those that typically move by rail; the trend toward more highly fabricated manufactures and toward freight of a higher value per unit weight; the trend toward product differentiation and competition among products on the basis of quality and service rather than price; and the urbanization of the population and growing self-sufficiency in the manufacturing capacity of metropolitan areas.

The segments of the freight market in which railroads hold a commanding economic advantage have diminished as the truck, the pipeline, the airplane have been developed to satisfy specialized transport needs. This reallocation of traffic on the basis of comparative advantage has caused the railroads to withdraw almost entirely from the passenger

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[52] Western Analysis, Montana Screening Matrix, 1979.

transport market, the small shipment market, and the local or shorthaul freight market.

Neither the railroad industry nor public policymakers can do much to slow the railroads' loss of traffic for which other modes possess a genuine comparative advantage. There are, however, indications that the railroads' loss of market share on this account may be coming to an end. The trucking industry has already diverted most of the high-value freight where the emphasis is on quality of service.

The traffic loss that should be of greatest concern to the railroad industry is the diversion of traffic for which the railroads actually still possess either a present or a latent comparative advantage. One of the most serious examples of the misallocation of traffic is large truckload shipments moving in excess of 200-250 miles, a distance beyond which railroads are generally conceded to have a comparative advantage. Roughly 57 percent of all common-carrier truck shipments exceeding ten tons move 300 miles or more. It is estimated that the revenues received by motor carriers and private trucking operations for the transport of truckload shipments exceeding 200-250 miles in length was nearly $5 billion in 1968, equal to 50 percent of that year's total railroad freight revenues.

Such misallocation of traffic raises the cost to society of freight transport by an estimated $1 billion a year. Among other things, it is estimated that trucks consume approximately four times as much fuel per net ton-mile as railroads.

One of the principal reasons for the loss of this long-haul traffic, is the unwillingness or inability of the railroads to improve and to differentiate the quality of rail service to the degree the market has

demanded.[53]

Technological Answers?

A major commitment to containers and inter-modalism - using a combination of rail and truck to deliver a shipment - is a necessary first step toward solving the railroads' problems by stressing their strengths and discarding their weak points.

Despite its comparatively rapid growth, containerized traffic still accounts for only about 5 percent of total railcar loadings, about 2 percent of freight tonnage, and about 6 percent of freight revenues.

Regulatory restraints, wherein some railroads enjoy rather broad rights to operate their own trucking fleets while others are restricted in varying degrees, are another major obstacle to rapid containerization. This forced reliance on independent motor carriers to provide pickup and delivery service for containers discourages their use. Containers and inter-modalism also can improve the speed and reliability of service along light-density branch lines, while at the same time lowering the costs to shippers. As long as the railroad is compelled to maintain train service over such lines, however, the incentive to introduce containers will be lacking.[54]

Another nagging problem, and an immense drag on railroad productivity, is the question of what to do with the parts of the rail network which have become superfluous and economically burdensome.

Large amounts of rural track were built to serve thriving communities (or the expectation of such communities) which had no alternative

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53 National Commission on Productivity, Railroad Task Force Report, 1974.

54 Ibid.

means of cheap transport in the nineteenth and early twentieth centuries. Many of these communities have declined or have even disappeared, while at the same time the highway has come to better serve the transport needs of most rural communities. Obviously, the affected communities protest since they are losing a valuable service, but the railroad, through perhaps no fault of its own or because of poor management, is going broke. (The use of centralized terminals or unit trains may also be appropriate.)

A commitment to containers and inter-modalism could allay these protests, allowing railroads to continue serving customers on lightly-used lines even as actual rail service on those lines was being phased out. In short, the railroads could be given permission to abandon rail operations along unprofitable lines without being allowed to abandon the traffic along those lines.

In addition to intermodalism, there are several other alternatives to outright abandonment of low-density lines, including smaller train crews, higher freight rates, operating subsidies to the railroads, scheduling abandonments well enough in advance so that all concerned parties could take appropriate measures to cushion the shock, and promoting alternate uses of such lines.[55]

Work rules, which are those elements of labor contracts that specify work assignments and the basis of pay, have protected railroad workers from involuntary and uncompensated displacement when innovations have been introduced, but have also proven a serious impediment to the effective deployment of railroad labor.

In general, the inflation of labor costs caused by work rules

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55 Stanford Research Institute, Evaluation of Potential Effects of Freight Transportation Abandonment, 1972.

encourages management to substitute capital and purchased services for labor wherever possible, so that the end result may even be to depress rather than sustain employment - ironically the opposite of what the unions have normally intended.

If public monies are channeled into "a rescue of the railroads," it might be done in a way that aids labor as well as capital.

There have been a number of notable technical innovations by the railroads during the postwar period, including dieselization, giant and specialized freight cars, automatic classification yards, centralized traffic control, mechanized maintenance, and automation of clerical functions. Examples of such possible changes are included in the following table.

TABLE 25

Possible Innovations.

Types of Innovation	Description and Impact
Motive Power Developments	More powerful units; solid state electronics improve electrical systems: higher tractive power per unit; greater overall reliability reduces maintenance.
Freight Car Improvement	Special cars developed for commodity groups; better bearings; higher capacity with reduced car weight to capacity ratio. Design and material improvements reduce loading and maintenance requirements.
Facility Relocation and Improvements	Repair station consolidation, including spot shop development, accompanied dieselization, resulting in greater efficiency. Car and locomotive washing and interior cleaning mechanized. Bad order car ratio reduced.
Piggyback and Unit Trains	Trains comprised of trailers or containers of general merchandise loaded on flatcars move on expedited schedules. Unit trains carry a single bulk commodity between two terminals. They are a vital link in production processes and their movement is on a strict time schedule.
Automatic Classification Yards	Large yards in which cars are sorted and switched by destinations have digital and analog computers to control car speeds and to aid in switching. Small yards equipped with automatic features now feasible. Increased car utilization, customer service and manpower savings result.
Computers	Both digital and analog computers in use. Computers have provided information processing and switching capacity that permits management better control of operations. Turnaround could be improved by as much as 40%.
Centralized Traffic Control (CTC)	Control of train movement over 50-100 mile or more stretches of track from a central location. A model of the track is operated by one man who pushes buttons or switches to keep trains moving in accordance with their priorities. Capacity of track is expanded and manpower savings result.

Source: U.S. Department of Labor, Railroad Technology and Manpower, 1972.

Potential Dangers

- Rehabilitation. One major danger associated with rehabilitation is that of "overkill." This refers to the possibility of federal assistance for marginal rehabilitation activities that provide no cash gains to the industry and little public benefit in terms of service gains or energy and environmental benefits. Alternatively, such federal overkill would simply result in replacing currently available private capital with public monies.

  The other danger associated with federal rehabilitation assistance is that of attaching such stringent financial terms that the funding cannot reach, or cannot benefit, the weaker railroads which need it most and which are otherwise forced to defer maintenance that would provide relatively higher financial and public returns.

- Restructuring. The danger here is that history will repeat itself and that undesirable mergers will be permitted to take place while the voluntary restructuring aimed at the weaker roads will be dragged through an endless procedural and conceptual morass. A planned and expedited federal response to (and participation in) industry-initiated restructuring appears to be essential.

- Rates. The dangers associated with rate reform are very real and involve adverse impacts on both the rail industry and the public. If done carelessly, the revision of historical regulatory treatment of the major modes could cause massive shifts of traffic away from the railroads. In addition, unrestrained freedom in the rate area could cause widespread increases in rail transportation costs. Such increases may be inevitable - and even desirable - over an extended period of time, but the potentially disruptive short-run impacts must be minimized.

Source: Office of Technology Assessment, A Review of Railroad Issues, 1976.

Technology in Trucking

What will the trucking industry be like in the future? Just a few years ago, a San Francisco consulting firm, Laird Durham Co., was hired by the Motor Vehicle Manufacturers Association to answer that question. In June, 1975, after months of interviews with industry association experts, businessmen, futurists, engineers and government

officials, they answered with a 72-page report in which they predicted in detail what trucking will be like in 1995, two decades ahead.

The Durham study foresees in 1995:

- A demand for truck transportation double the 1975 demand in ton-miles, with trucks gaining more market share from the railroads.

- A greater demand for private trucking than for-hire trucking because the service sectors of the economy will grow faster than the manufacturing sectors (service sectors are traditional private truck users).

- Trucks using alternative forms of energy.

- Line haul trucks as big as 100,000 pounds gross weight or more.

- Smaller, lighter, more energy-efficient and less noisy intracity trucks.

- Streamlined trucks for intercity and beltway use that will consume less fuel (4 to 8 percent less) and be quieter (15 decibels quieter).

- A big change in engines, with new emphasis on diesel engines capable of using synthetic fuels, turbine engines (in production versions) and the Stirling, an external combustion engine "which promises to burn anything."

- Electric trucks gaining widespread use in delivery route service if there's a technical breakthrough in batteries.

- Improved efficiency in terminal operations because computerization will streamline and centralize rating and billing operations.

- A change in trucking's priorities toward increased labor intensity and more emphasis on conservation of energy, capital and the environment.

More Exotic Possibilities - General

A recent survey by the McGraw Hill Corporation (1978) has produced a series of futuristic scenarios. The survey results of several hundred R & D and industrial experts is shown below.

This category combines two industries questioned separately in previous surveys, autos and railroads, since their futures are expected to increasingly overlap reflecting their similar functions. The ground transportation respondents felt that the breakthroughs had already occurred for the electric car, that economic feasibility could come as soon as 1990 and widespread use by 1995. Atomic powered cars and railroads seem unattractive on safety grounds despite the growth of technology in this field. Technology for such vehicles will be available by the year 2000 but its widespread use is increasingly questioned. Cars with gas turbines, hybrid-powered cars, even ground effect reaction vehicles all have more certain futures with technological development to full practicality expected within the next ten years. Various tracked vehicles, e.g., automated railroads and urban transit systems have similar practicality time horizons. Service free and accident proof cars won't be feasible until nearly the year 2000, if ever. Other refinements to present vehicles are more promising. On-board computers are being experimented with now and some sophisticated electronic controls will be in place in some car models in the early 1980's and should be in widespread use by 1985.

Finally, most respondents made note of ethanol in Brazil and methanol in Europe in response to the query on substitute nonpetroleum automotive fuels, but developments in the U.S. are not expected until the middle 1980's and widespread use until 2000.

TABLE 26

Technological Breakthroughs & Widespread Applications
by Industry or Field
(Median Year)

	Year of Breakthrough		Year When Economically Feasible		Year When in Widespread Use	
	1978 Study	1975 Study	1978 Study	1975 Study	1978 Study	1975 Study
GROUND TRANSPORTATION						
1. Low pollution automotive emissions	1980	1972	1985	1977	1985	1980
2. Cars run by gas turbine	1985	1975	1990	1985	1998	1992
3. The hybrid-powered car	1988	1982	1992	1987	2000	2000
4. "GERM" vehicles (ground effect reaction machines)	1985	1980	2005	2050	2020	2050
5. Automatic control of automobiles and trucks on highways	1992	1982	2000	2025	2008	2050
6. Autos powered by atomic energy	2000	2050	2015	2050	2025	2050
7. Service free car	2000	2000	2012	2000	2018	2000
8. Accident proof car	1998	2000	2005	2000	2010	2000
9. Automobile on-board computers	1980	1975	1983	1979	1985	1985
10. Substitute automotive fuels (nonpetroleum)	1986	1980	1988	1982	2000	1990
11. Multi-unit truck "train" running on its own traffic lane	1985	*	2000	*	2000	*
12. Automated urban transit	1985	1985	2000	1995	2010	2005
13. Automated railways	1982	1970	1990	2000	2000	2000
14. High speed tracked levitated vehicle	1986	1980	2000	2035	2005	2050
15. Atomic energy powered railroad	1990	1990	2000	2000	2035	2005
16. Noise free trains	1994	2000	2000	2000	2010	2000

* Not surveyed in 1975

Source: McGraw Hill, 1978.

Employment Projections

Rail employment declines have slowed within the last few years, motor carrier employment has increased at a constant rate since 1950. Technological improvement potential for both industries appears strong. Expansion of rail transportation would result in more efficient energy use, fewer land-use consequences, and less pollution by a substantial amount - 2 or 3 to 1. Capital requirements are, however, severe and rail profitability questionable at the present. Of course, this may improve.

In view of these considerations, it seems plausible that rail employment will stabilize and motor carrier growth slow somewhat. These employment projections are included (in the aggregate) in the summary section.

CHAPTER III

MONTANA'S FUTURE

Introduction

A funny thing happened on our way into the twentieth century. We became so obsessed with the blessings of technology and material growth that we overlooked the adverse side effects. The specter of the silent spring, poor resource management, and an increasing appetite for energy begins to loom in the minds of many concerned Americans and Montanans. People begin to ask: who's in charge here? And the answer was frequently - nobody. The tides changed, and in the minds of many equally conscientious people the current slant is every bit as much an over-reaction as the previous one. Balance between growth and environment is imperative. Without balance, we all will suffer.

This great debate, beginning in full in the early 1970's, has had several positive effects. Citizen input has dramatically increased and the basic legislation needed for environmental reform has been laid. Clearly, there have been negative aspects as well, including the delay of sound and reasonable technology. All technology is not bad. We as a society exist upon it and we must not lose sight of its importance.

Perhaps the very base of the argument is far deeper than the commonly quoted environmental and job trade-offs. It may be an issue of control - government versus business. Or, it may be an issue of society gradually altering its attitudes toward the materialism of a private economy.

Montana Tomorrow

Before focusing again on specific Montana industries it may be

useful to review a recent set of long-run projections to set the stage for the type of events which may alter these projections. When possible, the employment projections were made on the basis of projected output and productivity assumptions developed earlier in the report. In general the nonbasic projections are the result of demographic shifts in the work force, changes in participation rates and expected changes in the work week - another manifestation of technology. And as always, any long-term projection is no more than a guess.

The projections suggest several conclusions. First, it is likely that there will be very little employment change in the basic employment sectors - those sectors which are most affected by technology. Second, nearly all of the future growth in employment is likely to be found in service oriented activities. Third, although Montana's population growth will continue to be strong (with continued in-migration), the distribution of this growth is likely to be far from uniform. That is, there are numerous areas within the state (see Table 28) where out-migration is likely to continue. Nearly all of these slow growth areas are tied to the natural resource base (mining, timber and agriculture) and are more likely to be influenced by technological events.

TABLE 27

Employment/Population
Projections
(thousands)

Sector	1980	1985	1990	1995	2000
Agriculture	35.0	34.0	33.0	32.0	31.0
Lumber and Wood Products	9.5	9.8	10.0	10.0	10.0
Primary Metals	3.2	3.0	2.8	2.6	2.4
Food Products	4.1	4.0	3.9	3.8	3.7
Refining	1.1	1.1	1.1	1.1	1.1
Other Manufacturing	5.1	5.7	6.4	7.0	7.7
Metal Mining	2.0	2.0	2.5	2.5	3.0
Coal Mining	1.2	1.7	1.9	1.9	1.9
Other Mining	.8	.8	.8	.8	.8
Oil and Gas Extraction	2.5	2.5	2.5	2.5	2.5
Heavy Construction	4.2	4.2	4.2	4.2	4.2
Railroads	6.3	6.3	6.3	6.3	6.3
Federal Government	14.2	14.7	15.4	16.2	16.8
Total Basic	89.2	89.8	90.8	90.9	91.4
Other Construction	10.3	11.4	12.5	13.6	14.6
Other Transportation	6.9	7.7	8.6	9.3	10.0
Utilities and Communications	8.0	8.2	8.6	9.3	10.0
Trade	73.4	81.1	90.8	98.9	106.0
Services	58.9	67.2	76.4	83.2	89.2
Finance, Insurance, Real Estate	12.3	13.7	15.3	16.7	17.6
State and Local Government	56.3	61.1	68.2	74.4	79.8
Non-Farm Proprietors	40.6	44.1	49.2	53.7	57.6
Total Non-Basic	266.7	294.5	329.6	359.1	384.8
Population	783.2	822.6	869.9	909.9	952.4

Source: Western Analysis, 1978.

DIAGRAM 6

Employment Projections
(thousands)

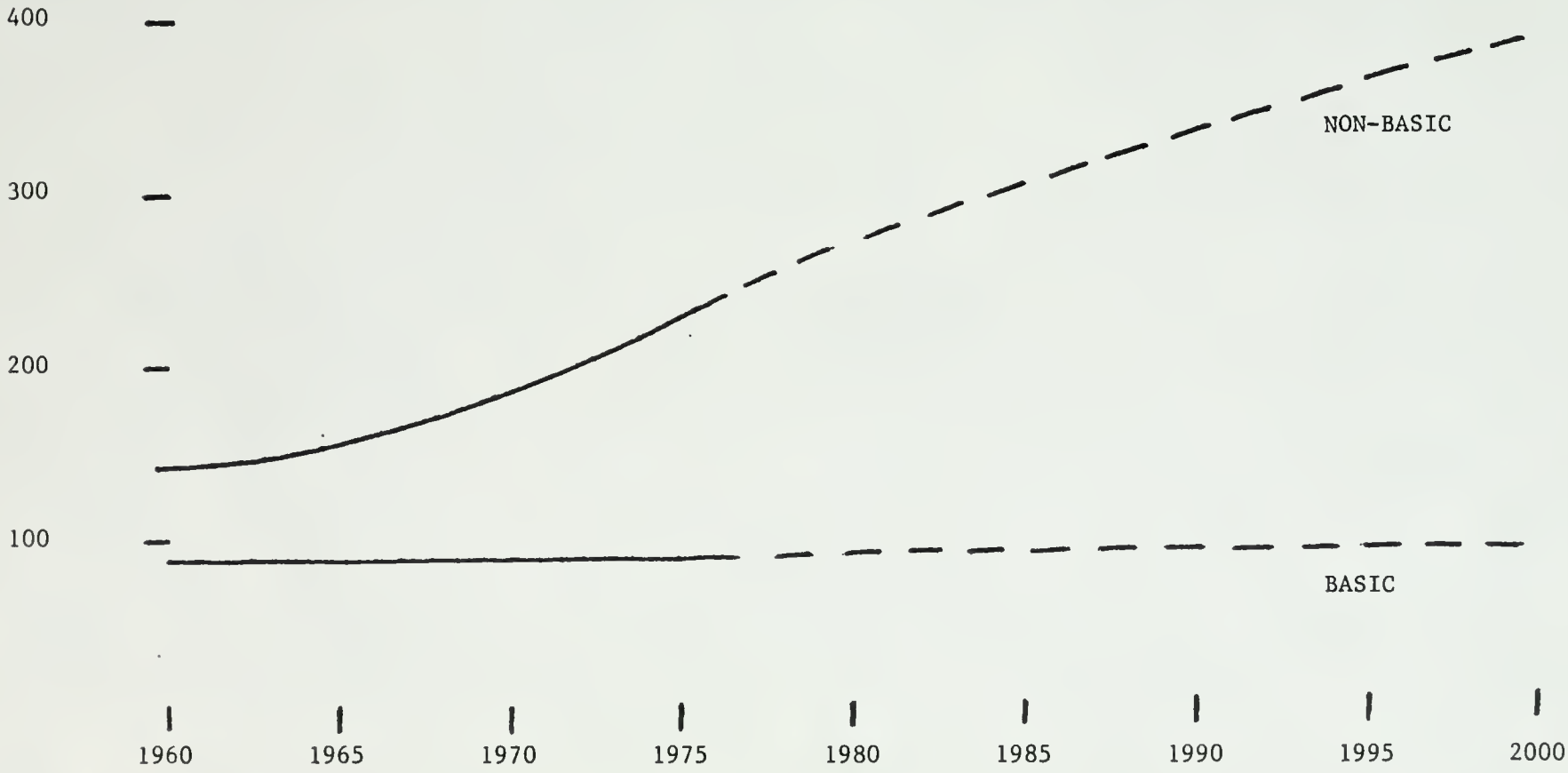

DIAGRAM 7

Population Projections
(thousands)

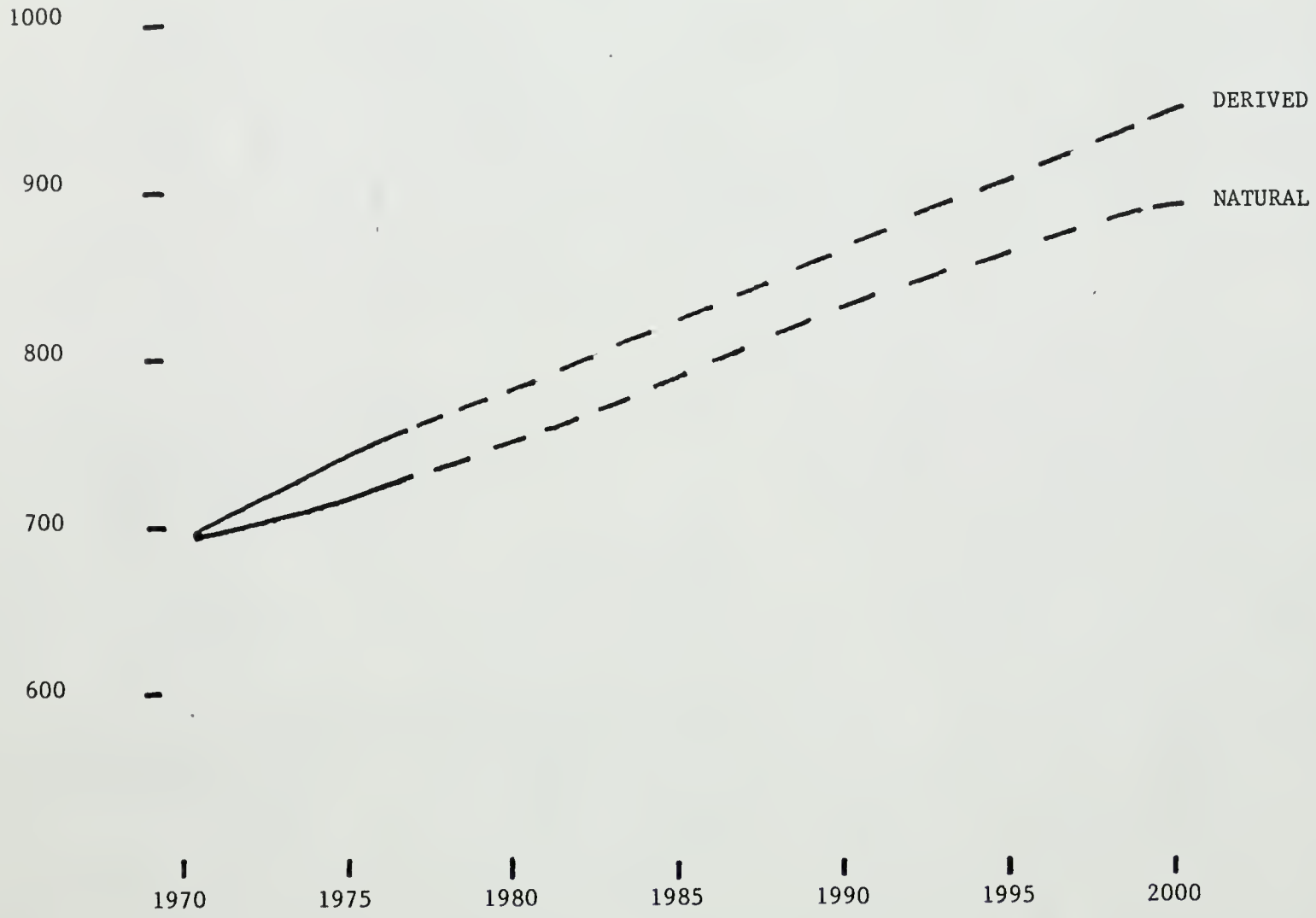

TABLE 28

JOB GAP
1990

County	Number of Jobs	Out-Migration
Silver Bow	2,700	6,800
Deer Lodge	2,100	4,400
Cascade	1,800	4,000
Glacier	1,800	4,100
Dawson	1,400	2,700
Hill	1,200	2,500
Lincoln	1,100	2,800
Blaine	1,000	2,100
Toole	900	1,500
Richland	800	1,500
Sheridan	800	1,400
Chouteau	700	1,400
Beaverhead	700	1,700
Pondera	600	1,400
Valley	600	1,500
McCone	600	900
Big Horn	500	1,300
Fallon	500	1,000
Powder River	500	1,000
Phillips	500	1,100
Custer	400	800
Judith Basin	300	600
Fergus	300	700
Liberty	300	600
Carter	200	400
Teton	200	600

Source: Western Analysis, Working Paper #6, 1979.

Agriculture

The underlying technological assumption for this sector is that future productivity increases will be similar to increases experienced within the last 15 years. Although significant breakthroughs in food production could occur (photosynthesis improvement, nitrogen fixation, irrigation efficiency, etc.) there also exist some very real constraints - fertilizer prices and environmental impacts, pesticides, diminishing land base, and probable energy shortages, etc. These sorts of issues may tend to cancel each other out.

Probably, the single most important factor influencing Montana's agricultural industry will continue to be world demand and the ability to pay. If technological advances do not accelerate in third world countries and if worldwide population growth does not slow, the demand for increased output will exist but possibly only in part. The ability to pay must exist and the price must be right for producers to effectively meet the need.

In view of national efforts to reduce inflation - a long-term problem of growing importance - it does not seem likely that federal policy will shift toward either subsidized exports or "gifts" of food to needy countries if they are unable to pay. And in view of the growing tendency of governments to wage economic wars, federal policy may very well drift toward using the competitive edge of agriculture as an international weapon. Montana will be very much a part of this potential showdown, should it occur.

Farm employment is likely to continue to decline and many rural areas which are dominated by agriculture will experience very slow or no growth. The size of a viable community will also increase. Although

some potential exists for food processing there is no evidence that possible gains in this sector could offset declines in primary production. Furthermore, if instate processing does expand, such expansion is likely to take place in more urban areas having little impact on small towns.

Ethanol plants, toted by some producers as having the potential for dramatically influencing prices, may very well develop but will have only a very limited impact on agriculture. Ethical considerations of using food to produce fuel would be difficult.

Agriculture is likely to be forced to drift toward less energy intensive practices - not just in fuel - but throughout the entire system. Conversion rates for feed beef represent a good example of inefficiency within agriculture. If grains become in short supply, beef production may again favor grass fat techniques.

Wood Products

It is unlikely that employment in this industry will grow very much in the future. And any growth which does occur is likely to be the result of new product development through technology, i.e., more efficient use of wood fiber. This view of the future is based on the assumption that the total timber harvest will remain relatively constant.

There is little dispute by industry experts that productivity on public lands could be greatly increased through intensive forestry. Decisions on the use of public land are, however, based on more than simple commodity values. It is likely that high yield forestry technology will continue to be a hotly debated issue between environmental and industry groups.

Technological improvements in sawmill efficiency will continue to allow the industry to get more out of the same product. And as prices rise, timber stands which were once overlooked will be economically practical to harvest. The use of forest residue may also become a reality - again resulting in greater utilization of the entire product.

The demand for timber and wood products is likely to remain strong well into the future. But, supplies are much more uncertain. Although the areas that are designated as wilderness under the RARE II process will have an effect on public timber supply, the effect will probably be quite moderate and not nearly as consequential as the general attitude of the Forest Service toward development on remaining multiple use lands.

However, it is possible that several mills located along the eastern front and in southwest Montana will have supply difficulties regardless of Forest Service policy. These mills, located in relatively marginal producing areas, may be overbuilt for the amount of actual timber available. They will be forced to haul timber long distances and pay higher prices if they are to remain in operation.

Timber prices are likely to continue to grow rapidly as bidders become more competitive for leases. Poor management practices on private lands (non-industry) can not be indefinitely maintained. Much of this land is not managed at all and may not add to the future timber base.

Montana may lose part of its competitive edge on the national market. High-yield practices and an improved timber cycle in the South may result in a moderate shift in production patterns. But in the end, the future of wood products in Montana is more likely to be associated with federal policy than it is with inter-industry

competition or technology.

Mining

The mining sector is currently the fastest growth industry in the state. Most of this growth, however, has occurred in oil and gas exploration. And, whether or not this growth continues can not be predicted. Simply stated, even though the potential for development is high, years will pass before this premise is born out or proven wrong.

Copper production has probably stabilized and the same should be true for employment in the Butte area. If rapid growth occurs in other non-energy minerals it is likely to be found in either chromium or iron development. Several major firms are already eyeing large deposits in the Stillwater Complex and in southwestern Montana. But again such developments are only "potentials" and may never be brought to fruition. Again, technology is probably not as much an issue as state and federal policy.

The same could be said for the future of primary aluminum production at Columbia Falls. The loss of cheap power and poor transportation access have the potential to significantly influence this operation, one of Montana's largest employers.

Coal development, like oil and gas, is dramatically affected by federal policy - specifically pollution control. At the present, coal appears to be a plausible answer to short-term energy constraints. But, the costs of development measured both in commodity and non-commodity terms will be high. The question is not whether coal output will increase, rather how much or how soon? But, this sector will continue to grow in importance within Montana's economy.

In general, it appears safe to say that all mining activity will be

more closely scrutinized in the future than it is today. Whether or not increased regulations will actually effect employment or simply the timing and costs of new projects remains to be seen. But with respect to energy development, time may be running out. A formal energy policy must be established weighing both economic and environmental costs so that a commitment can be made to a particular plan. Failure to do so will merely result in less conservation, greater bottlenecks on the part of industry, and the risk of economic disorder.

Transportation

Transportation policy also demands a thorough overhaul for the same reason - effective energy planning. Railroads use less fuel, produce less pollution, but unfortunately provide lower service and often require subsidy. The federal government, however, can not be blamed for the demise of the railroads - they went broke on their own and motor carriers and passenger cars simply picked up the slack. But now that energy prices are increasing exponentially, some reversals in the trend will probably occur.

Aside from light density lines, rail transportation is likely to slowly begin to pick up steam and become relatively more competitive with motor carriers. With rising fuel prices, a commitment to containers and inter-modalism may be the first step toward solving railroad's problems. Increased automation and improved traffic control may also help resolve many of the problems facing Montana communities subject to abandonment. Once the problems with the Milwaukee Road are resolved, total rail employment is likely to remain stable.

Motor carrier freight delivery is also likely to undergo

significant change - bigger trucks, greater relative efficiency, fewer empty backhauls. Employment will continue to increase.

Conclusions

What, then, is the direction of Montana's economy? The economy has been expanding rapidly since 1970 with increases in employment large enough to halt the high levels of net-outmigration which the state experienced throughout the two previous decades. Simply stated, employment increases have kept pace with population growth. This is obviously a very healthy sign for Montana's economy.

Although most of the new jobs have been in the service and trade sectors, income has steadily increased. This derivative expansion has not been unique to Montana but has been true for the nation as well. However, in order for this expansion to continue, the main sources of Montana's income and employment, the resource industries, must remain healthy.

Although Montana's remoteness and specialization in natural resource industries may give the illusion of being underdeveloped, it is not - it has just developed in a different way quite unlike the more populated, manufacturing areas. And even though Montana's industrial mix is specialized and somewhat narrow, it is very much a part of the national and world economy.

Montana does not necessarily "need" to transform to grow and attain a stable economy. The very fact of stable basic employment levels and rising population and employment attests to this conclusion. This should not imply that increased industrial diversification, when possible, would not benefit the state - particularly in certain areas - but that the overall economy of the state is doing quite well and should

prosper in the future. However, if any of the major natural resource or supporting sectors falter, the economic gains of the 1970's may quickly be lost.

These gains or losses will in all probability be the result of the acceptance or rejection of technology as it relates to natural resources. Light manufacturing and other less intense forms of development can not within the foreseeable future carry the economy of the state. To be sure, industrial diversification will occur in Montana. But this metamorphosis will be slow as it was elsewhere and will be determined by economic feasibility rather than wish.

Montana is fortunate to be well endowed with timber, minerals, and extensive agricultural lands. The future of Montana will rest on these riches and upon the decisions which effect their use. Polar extreme arguments will benefit no one since important decisions are never made on the basis of "black and white" criteria.

Many crucial trade-offs will exist in the future. For example, a national farm policy which would benefit Montana would necessitate higher food prices, and would be met with resistance nationally. Timber cutting and mining policies are even more complex when environmental costs are weighed. No simple solutions exist in such complex situations, but Montanans should insure that their input is made known to national and state decision makers, both private and public, when the vitality of the economy and the quality of the environment are at stake.

The human factor is often overlooked in such decisions in the sense that it is far easier to say - I want a coal mine or I don't - I want wilderness here not an oil field - I want good fishing not irrigation,

etc. The full list of such possibilities is nearly innumerable. And it is far easier to make such decisions or comments when the effects are not personally felt. In other words, try telling a logger he "needs" wilderness or a farmer that he can't sell his land. Jobs and people are important, just like the natural environment.

Unfortunately, the term environment has through common use been associated with a biological state. But the environment is much broader in scope. It is the set of circumstances, objects, or conditions by which one is surrounded. This includes jobs and technology and people in addition to air, land, and water quality.

A wilderness can benefit our environment and so can technology if wisely used. The problems created by poor technological choice and motive can be resolved by technology. Past mistakes should not be repeated, but the promise of technology should not be overlooked. All problems can be resolved and often the conflict surrounding the problem exceeds the problem itself.

With good judgment, Montana will be as it is today, healthy and prosperous - a good place to live. But, if Montana chooses to make no decisions or if the state makes decisions which are not consistent with national goals, then those few decisions that we influence will be made elsewhere by individuals far less sensistive to Montana's "total" environment.

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WESTERN ANALYSIS

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April 15, 1979

Mr. Bruce H. DeRosier, Director
Governor's Employment and
Training Council
Capitol Station
Helena, MT 59601

Dear Mr. DeRosier:

The following report entitled "Technology and the Future of Montana" represents a review of past, present, and possible future changes in technology, and how such changes have or could impact the state's economy.

This document submitted in fulfillment of contract 59002 will be used, in part, in a more comprehensive report summarizing the future of Montana.

I hope that you find the analysis both interesting and useful.

Sincerely,

Bruce Finnie

Bruce Finnie
Vice President

P. O. Box 287 • Helena, Montana 59601 • Telephone (406) 443-3420

DCA MONTANA DEPARTMENT OF COMMUNITY AFFAIRS
Capitol Station, Helena, Montana 59601
Thomas L. Judge
Governor

March 21, 1979

Dr. Bruce Finnie
Vice President
Western Analysis, Inc.
Box 287
Helena, Montana 59601

Dear Bruce:

At your request, I have reviewed your report entitled "Technology and the Future of Montana's Economy" (April 1979). I have both general and specific comments regarding the report.

In general, the report represents a useful draft working paper on the subject of technology and the future of Montana's economy. A person wishing to check out a reference used in the report would do so with some difficulty, however. This is because most reference footnotes and items in the bibliography are much shorter than the standard form. In addition, items from this Division's most recent publication entitled "Economic Conditions in Montana: A Report to the Governor" (December 1978) were extracted without any reference whatsoever. At the same time, I realize that the contract under which the report was written may have been small in size, and may have had objections that dictated a looser formulated document.

Specific comments on the report are as follows.

1. The use of input-output analysis to describe the effects of technological change was a very useful and interesting part of the report.

2. The most recent data for 1978 indicates wood products industry employment to be 10,700. This figure is higher than the 1973 level which is contrary to the information presented on page 45 of the report.

3. The way in which mining and the processing of minerals were combined in the report is somewhat confusing to the reader at times (e.g. page 55 - "To this day, mining, Montana's first manufacturing industry, still remains the largest.").

4. The projection for copper production and employment may be low, given the current price of copper of $ .90 to $1.00, $ .30 to $ .40 higher than a year ago.

Sincerely,

Phillip D. Brooks, Senior Economist
Research & Information Systems

March 27, 1979

Bruce Finnée
Vice President
Western Analysis, Inc.
Box 237
Helena, Montana 59601

Dear Bruce:

I have just reviewed your manuscript, "Technology and the Future of Montana's Economy", to find that you have ludidly addressed what I feel are the major themes necessary to cover the subject. You have identified for the major Montana industries those technical relationships whose change would materially affect the economic well-being of Montanans. This information should prove to be quite useful to those individuals who wish to have some insight into the potential consequences of different technological changes for the residents of this state. The contents of this document would especially be useful for individuals engaged in development of human resourcespolicies and plans to meet future human resource contingencies arising from major technological changes.

Sincerely,

Marc Wiitala, Economist
Research & Information Systems Division

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